DISPOSAL OF REFUSE.

REPORT

TO THE

SANITARY COMMITTEE

OF THE

HONOURABLE THE COMMISSIONERS OF SEWERS OF THE CITY OF LONDON,

UPON

SOME NEW METHODS OF DISPOSING OF ALL KINDS OF REFUSE BY CREMATION;

BY

W. SEDGWICK SAUNDERS, M.D., F.S.A.,

MEDICAL OFFICER OF HEALTH AND PUBLIC ANALYST FOR THE CITY OF LONDON,

LATE PRESIDENT OF THE HUNTERIAN SOCIETY, &c., &c.;

TOGETHER WITH

EXTRACTS FROM THE REPORTS OF THE SANITARY AND STREETS COMMITTEES

UPON THE SAME SUBJECT.

Ordered to be Printed 25th January, 1881.

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At a Meeting of the Commissioners of Sewers of the City of London, held at the Guildhall, on Tuesday, the 25th January, 1881,

THOMAS RUDKIN, Esq., in the Chair.

A Report from the Streets Committee (George Rose Innes, Junr., Esq., Deputy-Chairman), dated this day, was read—

Relative to a Conference had with the Sanitary Committee respecting a process for disposing of Refuse; expressing a general concurrence therein, and recommending that it be referred to this Committee for further inquiry, with authority to take such steps for that purpose as they may deem advisable.

A Report from the Sanitary Committee (Henry Hodsoll Heath, Esq., Deputy-Chairman), dated this day, was also read—

On the Reference of the 2nd November last, relative to the disposal of Refuse, &c., with a Report from the Medical Officer of Health there-

upon, and recommending that the Commissioners communicate with Messrs. Manlove, Alliott, Fryer and Co., Patentees of the Destructors, &c., with a view to obtain Estimates and Designs.

The Medical Officer of Health was heard.

RESOLVED—That the proceedings of the Streets Committee and Sanitary Committee therein be approved, and that it be referred back to the said Committees conjointly to inquire further into the matter and to report.

RESOLVED ALSO—That the Reports of the said Committees, together with the Report of the Medical Officer of Health upon the subject, be printed and circulated as usual.

HENRY BLAKE,
Principal Clerk.

EXTRACT

FROM THE

REPORT OF THE STREETS COMMITTEE,

25*th January*, 1881.

WE whose hands are hereunto set, your Streets Committee, beg to report that we have recently had a conference with the Sanitary Committee relative to a process adopted in some of the large provincial towns for the destruction of all manner of objectionable Refuse, and which it appears might with advantage be applied to the work carried out by this Committee.

We beg, therefore, to recommend that the matter be referred to us for further inquiry, with authority to take such steps for that purpose as we may deem advisable.

(*Signed*) THOS. RUDKIN.
G. ROSE INNES, Junr.
WM. BLANCH.
WM. BRAHAM.
WM. BASSINGHAM.

EXTRACT

FROM THE

REPORT OF THE SANITARY COMMITTEE,

25th January, 1881.

AGREEABLY to your Reference to us of the 2nd November last, we have taken into consideration so much of the Medical Officer's Report of that date as relates to the disposal of Refuse by new methods recently adopted in some of the large provincial towns.

We appointed a deputation to visit Leeds and other places where the new processes are in operation, and they appear to have been much impressed by the great facilities afforded thereby for getting speedily rid of a large amount of objectionable refuse without any nuisance.

One of the most important processes as regards the work of this Committee is that whereby the Meat condemned as unfit for human food may be disposed of with great facility, and so as to obtain the largest amount of value therefrom, but in the course of the Committee's investigations they were made acquainted with a process by which all kinds of objectionable material are destroyed, and which it appeared to them might be of immense assistance to the Streets Committee in getting rid of the vast amount of Refuse which they have to dispose of. And it was manifest also that great advantage and economy might be secured in combining the two processes, viz., the one for dealing with the meat, and the other for the destruction of Refuse.

By our direction the Medical Officer is preparing a Report upon the whole subject, including the proceedings of the Deputation, which will be submitted to you, and we beg to recommend that your Honourable Court communicate with the Patentees, Messrs. Manlove, Alliott, Fryer and Co., with a view to obtain estimates and designs for applying the said processes to the operations of

the character in question carried out by your Honourable Court.

(*Signed*) H. H. Heath.
Thos. Rudkin.
Wm. Jas. Scott.
G. N. Johnson.
Wm. Pitman.
Thos. Woodley.
Joseph Surr.
John Hughes.
Washington Lyon.
Geo. C. Boor.

ON SOME NEW METHODS OF DISPOSING OF ALL KINDS OF REFUSE BY CREMATION.

TO THE SANITARY COMMITTEE OF THE HONOURABLE THE COMMISSIONERS OF SEWERS.

GENTLEMEN,

In compliance with your Resolution of the 18th January last, "That it be referred to the Medical Officer of Health to prepare a Report upon the whole subject (*i.e.*, the destruction of Refuse, and Condemned Meat), including the proceedings of the Deputation to the North of England, entering into such details, and with such recommendations as he may think advisable," I beg to offer the following remarks.

PART I.

The removal and disposal of house refuse is a problem which has exercised the intelligence, and often strained the resources, of many a sanitary authority, and he who can indicate the means whereby it can be successfully solved without detriment to health, or the creation of nuisance, should be regarded as a public benefactor.

House refuse consists of cinders, coal-ash, dust, and every conceivable kind of domestic waste, mixed with substances which ought never to be placed in the dust-bin, but burnt in the kitchen fire ; the latter are vegetable and animal productions, which rapidly decompose, not to mention the excremental products of men and animals, too often observed in the public dust-bins of our worst courts and alleys ; it is of the highest importance, therefore, not only that this refuse should be removed before the germinal products of putrefaction can do their deadly work in poisoning the atmosphere, but that all further manipulation *after it has been collected by the scavenger* should be strictly prohibited.

A different practice has obtained up to the present time, and establishments on a large and costly scale have been erected for the purpose of separating and sorting the refuse into its component parts after it has reached the deposit-grounds, with a view of extracting a modicum of grain out of a bushel of chaff ; indeed, the primary object of some administrators appears to be, to recoup themselves of the inevitable cost of collection by methods which are alike offensive to the senses, dangerous to the neighbourhood, and injurious to the employés. In this way a noisome trade is carried on, and the anxiety evinced to show a profitable return for the dirty work seems to dominate the sense of responsibility which attaches to the function of a sanitary authority ; so keen has been the desire to obtain the crude material in some districts that penal consequences are involved by any attempt on the part of a householder to sell or utilise his house refuse other than to persons who contract for its removal with the local authority (25 and 26 Vic., cap. 102, Sec. 89).

I am far from thinking that it may not be legitimate, and even laudable, to endeavour to secure some return for the heavy cost of collection, always provided as a condition precedent that, whatever the method adopted, its working and products are inoffensive; but I say, that this should be subordinate to the higher duty of preserving the public health.

In all the great metropolitan dust yards I have visited, the principles which should govern the conducting of the business have been grossly violated, and noxious manufactures on a gigantic scale, and of the most pungent and unwholesome kind, have arisen, and are connived at, by those whose primary and statutory functions are the suppression of everything tending to create nuisance or propagate disease. The inhabitants of premises adjacent to these places are becoming sensitive as to the consequences likely to accrue from any extension of this class of trading, and within the last year two of the largest Vestry authorities in the metropolis have had to defend their share in the matter in the Chancery

Division of the High Court of Justice. The result was so characteristic of the "glorious uncertainty of the law" that I may be forgiven mentioning it. One learned judge decreed an immediate injunction against the defendants, upon the grounds, that every inhabitant of a city, or district, was entitled to the comfortable enjoyment of his dwelling, free from nuisance of any kind, although it might not go to the extent of producing actual disease. The other judge refused the injunction, for the reason, that it appeared to him that the Vestry complained of had done all in their power to prevent evil consequences arising from the business carried on at their dust yard. Possibly both these decisions may be reversed when the actions are tried "upon their merits" before a jury. These cases should be accepted as a wholesome warning, that, as education extends, and the preservation of the public health, and the prevention of zymotic (*stink-engendered*) disease, becomes a matter of common concern, no Local Authority, however wealthy and powerful, will be permitted to pollute the air of densely-populated centres of

civilisation with mephitic odours, which induce nausea, loss of appetite, and other of the minor miseries of life, for their own profit and advantage; and no amount of forensic ability will induce twelve intelligent jurymen to believe that a system which ignores the first principles of hygiene should be allowed to continue an hour after it has been proved to demonstration that house-refuse can be disposed of without nuisance, or danger of infection, by the introduction of modern mechanical inventions, scientifically conceived, and skilfully applied.

Having been engaged professionally in each of the instances above cited, I could not help reflecting, that as Lett's Wharf is within one hundred yards of one of the defendant's premises, perchance the Commissioners of Sewers might find themselves furnishing a *third* illustration of the proverbial fickleness of judicial wisdom, and, that I might be placed in the painful predicament of being required to certify, that modes of procedure, sanctioned by them, and carried on by their servants, could be justified upon any other ground

than that of expediency. It behoved me, therefore, as their responsible adviser in sanitary matters, to make myself acquainted with the methods for dealing with house refuse adopted with their approval ; accordingly I paid many visits to Lett's Wharf, sometimes meeting with the Chief Commissioner, or the Chairman of the Streets Committee, and I am compelled to add, I always left it with a feeling of regret that more has not been done to remedy evils which the most ardent admirer of established customs must deplore.

LETT'S WHARF.

It may be interesting to those Honourable Commissioners who may not have seen Lett's Wharf if a brief description be given of the work done, in relation to the treatment of house and trade refuse, at that place, and the following particulars, obtained from Mr. Swale and his assistants, may be relied upon.

From 600 to 700 cart-loads of *dust*, comprising cinders, coal-ash, paper, rags, &c., vegetable and

animal matter, [technically termed *soft core*] are *received* weekly during the winter months, and from 500 to 600 cart-loads during the summer months, or, estimated at an average of 600 loads per week, 31,200 loads per year. This quantity was, in 1879, made up to a total of 62,797 cart or wagon loads, by slop (street mud, &c.) and trade refuse, which the Superintendent reports is an increase of 9,000 cart-loads over the average of the previous ten years.

In the same Report, dated 23rd January, 1880, it is further stated that during the twelve months of the preceding year 985 barge-loads were *removed* from the Wharf ;—comprising 352 barge-loads of *ashes and breeze*,—589 barge-loads of *manure*, and 44 barge-loads of *hard core*, and it is significantly added, "that should this increase continue, it will be desirable to find out *some other mode of getting rid of a large portion of the refuse.*"

When the dust carts arrive at the Wharf, their contents are tipped into heaps at the place most

convenient for the people who are employed as sorters. About 70 persons, chiefly women, are engaged in this degrading and loathsome work; most of whom are paid by piece work, but 16 female sifters receive seven shillings, and a little coal and wood, weekly. The appearance of these women is most deplorable; standing in the midst of fine dust piled up to their waists, with faces and upper extremities begrimed with black filth, and surrounded by, and breathing, a foul, moist, hot, air, surcharged with the gaseous emanations of disintegrating organic compounds, they resemble the denizens of the place said to be paved with good intentions, rather than the image of their Maker. [I shall never forget visiting some of these poor creatures in hospital, and witnessing the condition of their skins when the accident to the chimney shaft occurred.]

The dust is placed into large circular sieves, which are worked by the sifters and divided into two portions:—1st, the finer part, which falls at the feet of the operators, and partly buries them; 2nd, the coarser part, which is thrown

on one side for the next process. This consists in the separation and sorting of the larger articles, such as clinkers, bottles, old metal, crockery, paper, corks, bones, rags, string, &c., &c., which are industriously placed in distinctive heaps for sale. The sifters and sorters are employed by a general contractor, to whom the commissioners pay ninepence per load for the work, the contractor taking, as well, the paper, *whole* bottles, rags, iron, tin, &c., but leaving the *breeze* (cinders and particles of unburnt coal), *soft core* (animal and vegetable and textile substances), and *useless* hard core (worn out pots and pans, and large articles). This payment of ninepence per load amounts to from £20 to £25 per week. The scraps of paper fetch from 25s. to 30s. a ton,—rags 20s. a ton,—bones 50s. a ton,—iron 20s. a ton,—metal 18s. a cwt.,—tin-ware 3s. a cart-load,—corks 1s. per bushel,—bottles 9d. a gross. The barges are loaded with the breeze and fine ash, in the proportions of 1 to 2, and sold to brick-makers from 2s. to 2s. 6d. per chaldron:—barges hold from 60 to 70 chaldrons. The *hard core* (clinkers, broken bottles, and crockery) is used for road making, and

the Commissioners have frequently to pay the barge owner 50s. a barge load for its removal ; about one load a week is thus disposed of. As far as I can ascertain the expense incurred in the work includes : a general manager and salesman at £225 per annum ; a ganger at 50s. per week ; twelve men at 5d. an hour, day work, or 3d. per chaldron for stuff shot into the barges ; a lighterman, to look after the barges and berth them, at 35s. a week, and a house ; and a furnace-man at 4d. per hour, 10 hours a day. These charges are irrespective of the general staff of the yard, and those employed outside its walls.

In entering upon these details I have, for the sake of brevity, restricted my observations to that portion of the work done at Lett's Wharf which bears upon the subject of house refuse only, and have referred to some of the items of cost, in order that an approximate estimate may be formed between the expenses attending the system I condemn and that which I advocate herein.

Before passing to the more immediate object of this Report, I desire to call attention to the plan of treatment which now obtains respecting the horse manure collected by the street orderly boys throughout the public highways in the City of London. These *horse droppings* are mixed, upon a platform on the open wharf, with soft core, slop, every animal abomination, offal, stinking fish, &c., and sold, at certain seasons, to farmers at £2 a barge load of about 40 tons. I must here, in parenthesis, enter my emphatic protest against this *adulteration* of manure, being, as I have frequently seen it, a practice attended with noxious exhalations of a sickening character, which, but for the oxydising and deodorising influence of the surrounding air, would have induced a panic in the neighbourhood long ago; morever, it materially lessens the intrinsic worth of a highly concentrated manure, and should no longer be tolerated. The excuse offered for this extraordinary sophistication is, that it facilitates the clearance of a class of offensive material for which there is no market *per se*, albeit it diminishes the fertilising qualities of a stimulant which came originally from the land,

and should be restored to it in its natural condition, intact. I point out this particular blot upon the practice at Lett's Wharf without the smallest intention of reflecting on the general management of your excellent and zealous Superintendent, who, it may be fairly assumed has only been driven to this device from the inherent difficulty of otherwise getting rid of a mass of inert, and inconvertible, matter ; such as oyster-shells, and other crustacean sweepings of Billingsgate Market, and fishmongers' shops ; and who, I am equally certain, will be thankful to be relieved of the necessity of deteriorating the real commercial value of the horse-droppings, and with less reluctance than I should otherwise feel, since the plan I am about to suggest will render the process indicated no longer necessary.

Of late Mr. Swale has had great trouble in selling it, owing to the universal distress in agricultural districts ; in addition to which the stuff accumulates to an inconvenient extent when, from continuous wet weather, or other circumstances, the manure cannot be worked into the land. So

serious has this difficulty become, that at the present time we are absolutely *giving it away* to avoid complaints from our neighbours.

During the late prolonged severe frost the barges were immovable, and the collections at the wharf increased to such an extent that very considerable anxiety was felt thereat. As this contingency will occur periodically, and water-borne goods cannot be carried when the vessels are blocked in with ice, the plea "*for some other mode of getting rid of a large portion of the refuse*," before quoted, obtains force.

The Local Sanitary Authority will not allow our furnace to be used for consuming refuse *during the day time*, in consequence of the nuisance arising from smoke, and this necessarily limits very seriously the amount of work done at the wharf.

It was thought at the time this furnace was erected, about three or four years ago, it would prove a valuable auxiliary; but, useful as it has undoubtedly been, the work required exceeds its capabilities, and the Superintendent has reported that it is

"*quite inadequate for the purpose of burning what in my opinion should be burnt,*" a fact which is patent to everyone who has witnessed its operations.

In the face of all these drawbacks to a system established at a prodigious cost, and commenced with great expectations, and regarding the treatment of house refuse as belonging exclusively to the Sanitary Department, it seemed incumbent upon me to make diligent search for a comprehensive remedy.

Reflecting over the question in all its bearings, my mind was led irresistibly to Nature's great purifier, **heat**, and the outcome of the inquiries, instituted in consequence, was the system of **cremation**, which constitutes the *raison d'être* of this Report.

Since the summer of 1877 I have been carefully observing the progress of plans, which were then inaugurated, for the complete destruction by fire of the following kinds of refuse, viz.:—MINERAL MATTER (cinders, ashes, metals, crockery, glass); VEGETABLE MATTER (sweepings of paved roads and

vegetable and fruit markets, damaged straw, garbage, &c.); ANIMAL MATTER (contents of cess-pits, slaughter-house sweepings, blood, offal, and at times diseased and unsound meat and fish).

It has been asked why I have not referred to the subject earlier, to which I would reply, that the proposed innovation involves a complete revolution of established practices, and the abandonment of the doctrine of making a profit out of the business, and consequently no move in the direction contemplated could, consistently with any regard for one's reputation, be made until every means of practically dissecting the probabilities of the case had been exhausted.

At a Court of Sewers, held on 2nd November last, I reported as follows :—

"THE DISPOSAL OF REFUSE, &c.—For the last "three years I have been attentively watching the "development of new methods for dealing with the "refuse, excreta, &c., of large towns, whereby the "various processes connected therewith may be "carried on with a minimum degree of nuisance

"or of injury to health; and believing that the "law will before long interpose, to prevent the "business being conducted in the centres of large "populations, and that works of this kind will be "relegated to districts beyond the range of human "habitations, I am impelled by a sense of duty to "mention the subject, and to advise you to refer "it to your Sanitary Committee, for them to "thoroughly investigate the whole matter, and take "such steps to inform themselves therein as they "may deem fit. Many of the Sanitary Authorities "in England and on the Continent are moving in "this direction, and I am unwilling that the City "of London should be behind in a question of the "highest importance and interest in a sanitary, "social, and commercial point of view."

The matter was referred to the Sanitary Committee for them "to take such steps as they may find necessary to inquire fully into the subject, and report."

The Sanitary Committee forthwith proceeded to consider the same, when having, at their request, explained in detail the methods alluded to above,

and indicated the sources of further information, I was instructed to make the requisite arrangements to enable them to view certain towns in the North of England in which the process of treating house refuse by cremation in specially designed furnaces has been adopted. A deputation was appointed for this purpose, consisting of the Chairman (Thomas Rudkin, Esq.), the Deputy-Chairman (H. H. Heath, Esq.), and Messrs. W. J. Scott, T. Woodley, Washington Lyon, J. Surr, G. N. Johnson, and the Principal Clerk. The Chairman of the Streets Committee (G. R. Innes, Esq.) and myself were also invited to accompany them. I at once opened up communications with the inventor of the Destructor furnace, Mr. Alfred Fryer, of Nottingham, and with his active and ready co-operation obtained permission from various municipal authorities to visit several districts in which the wholesale cremation of refuse was on its trial

Accordingly the Deputation left London on Wednesday, 12th January, 1881, and spent four days in this important investigation. They went first to Nottingham, and were conducted over the

extensive engineering premises of Manlove, Alliott, Fryer and Co., the patentees of the machinery employed in burning refuse, and having inspected the various models, drawings, and plans submitted and explained to them by the heads of the several departments, felt perfectly satisfied of the capabilities and resources of the Firm to execute works of any magnitude. Subsequently Leeds (Armley Road and Burmantofts Station), Bradford, Warrington (Farnworth and Longford Depôt), and Manchester were visited, and the methods under consideration were seen in actual operation, and thoroughly examined.

The system alluded to involves two propositions, viz. :—

i. The destruction by fire of everything combustible in House and Trade Refuse.

ii. The separation of the vegetable from the animal and mineral matters, and its conversion into Charcoal.

The *first* process is achieved in an apparatus termed a **Destructor,** the *second* in a furnace called a **Carboniser.** These we will now describe.

The Destructor.

The "Destructor," as invented by Mr. Alfred Fryer, of Nottingham, is "a form of furnace designed for the reduction by fire of substances that contain only a small proportion of combustible material."

As erected at Armley Road, it represents externally a cubical mass of brickwork, about 22 feet wide by 24 feet deep and 12 feet in height, all well tied and bolted together with strong iron rods, which perforate the whole structure.

The top forms a perfectly flat platform, having an opening about three feet square over each cell, into which the refuse to be burnt is shot directly from the collecting carts. An oval shaped service hole of larger dimensions is also provided for the admission and destruction of infected beds, mattresses, bedding, and other bulky articles. In direct continuity with this platform is an inclined roadway, up which the carts laden with refuse travel. This need only be of sufficient width to enable carts to pass each other on their journeys

up and down the incline. It ends at its upper portion in a piece of level ground about three or four feet higher than the top of the destructor, so that the carts can back on to a strong wooden baulk, or curb, and shoot their contents directly on to the mouths, or feeding inlets, of the furnaces, without any further manipulation than the act of tipping, or tilting. In this way an enormous amount of labour is saved, and the inevitable nuisance created by the process of sifting and sorting altogether prevented: an advantage which must commend itself strongly to the judgment of every practical sanitarian.

Internally it consists of a double set of three cells placed back to back, or in all six compartments, each of which is in direct communication with a tall chimney shaft ; a cell, therefore, constitutes a separate furnace, consisting of a cavity inclosed by a reverberatory arch, both being lined with fire bricks ; it is supplied with a hearth for the reception of the material to be consumed, from which it passes into the furnace proper ; the fire bars are placed in an acutely slanting position,

in order to favour the passage of the heavier and incombustible portions of the refuse, downwards, to the front doors, and thereby facilitate the removal of clinkers, &c. These fire bars are ingeniously made and represent in section an isosceles triangle, the base of which is placed upwards, so that when the burning refuse becomes sufficiently comminuted to pass through the upper surface of the bars, the small ash falls into a receptacle below, and all chance of choking, the effect of which would be to diminish the draught, is prevented ; they are very durable since those we examined at Armley Road Station appeared to be quite perfect, although, the Superintendent in charge informed us they had been in constant use during the last 14 months, and had burnt over *fifteen thousand tons* of refuse.

Each cell has two openings into the reverberatory arch which correspond with the back end of the furnace ; one of these is for the admission of the refuse as above described, and the other for the exit of the gaseous products of combustion into the flue ; between these two openings is a brick wall which constitutes a diaphragm and prevents

the refuse as well as the gases finding its way into the flue: it is also provided with an ordinary furnace frame and doors; the latter are required for two purposes, *firstly*, to start the furnace with fuel when commencing operations; *secondly*, for the extraction of metallic articles [from a tea-kettle to a sardine box], and the clinkers which result from burning refuse [containing every conceivable kind of incombustible waste]:—When the furnaces are in full work, the clinkers, &c., require to be withdrawn every two hours, and, at about the same interval, the attendant on the top of the destructor commences shovelling in a fresh charge.

One man suffices to feed six cells for the day working, but two are required for the night shift, most of the refuse being delivered after sunset.

Each cell will consume *seven tons* of refuse in 24 hours; therefore a Destructor containing six compartments will consume *13,104 tons* in fifty-two weeks of six working days; and of the total mass delivered 80 *per cent.* is entirely consumed by

the fire. [In certain hygroscopical states of the weather, and during heavy fogs, the draught of air is diminished very considerably and consequently less material is consumed.]

A large amount of waste heat necessarily results from the process, since the caloric is radiated from the reverberatory arch on to the burning material; the hot gases thus generated can be utilised on their way to the chimney shaft and made to raise steam, in a multitubular boiler of 6 feet diameter and 10 feet in length, and driving power created at a pressure of 40 lbs. to the square inch, and a temperature of 287·1° Fahrenheit, equal to working two powerful mortar mills with pans of 8 feet in diameter, by means of a horizontal engine of 14-horse power with 12 inch cylinder and 2 feet stroke; or the steam might be employed for concentrating any liquid (in vacuo) however offensive, without any perceptible smell; indeed it would be tedious and profitless to enumerate all the various ways in which this vast motive agent could be applied in establishments of any magnitude; an advantage be it remembered

obtained absolutely without cost after the boiler and gearing have been paid for.

The chimney shaft attached to the Destructor forms a very important adjunct, and should be of sufficient height, in order to prevent fine particles of dust being distributed over the neighbourhood; that at Armley Road is 126 feet high:—at Manchester it is 160 feet:—at Bradford it is 180 feet high; [*internal diameter* 7 *feet* 10 *inches, and* 8 *feet* 6 *inches at top; external diameter* 14 *feet* 1 *inch at ground line, lined with fire brick up to* 40 *feet*]:—at Birmingham 170 feet; in the latter place it was originally 120 feet only, but it was found necessary to raise it 50 feet, which remedied all objection to the lower level, and had the effect of materially increasing the power of the Destructor.

Having been informed that inconvenience had been felt in some places from the escape of very fine gritty dust from the top of the chimney, I wrote to Mr. Fryer on the subject, and received the following reply dated March 15th, 1881. "I believe there is no example of dust escaping from any of

the chimneys unless the flues have been allowed to become nearly choked with dust. The fact is that if fine dust once ascends a chimney shaft it would go up 200 feet, as easily as it would 50 feet, and the art is to make the flues so large as to allow of the *accumulation* of the dust. We therefore make them so large that the reduced velocity deposits the dust. There is less chance of dust escaping from a Destructor of 12 cells than one of 6 cells, because, when the furnace doors are opened the increased rush of air augments the general velocity of the gases in the flue, and as only one furnace is opened at once the mischief in the one case is twice as great as in the other. With large flues I think that a chimney of 120 feet high will be quite suitable. We want a sufficient height to produce a keen combustion, and this will do it. I may say, that for London I propose to enlarge still further the area of the dust chambers. Of course while the height of the chimney remains the same the sectional area required will increase with the number of cells."

This letter has removed from my mind some

misgivings upon the subject, although I cannot implicitly accept its reasoning; nevertheless, it is entitled to respect, as coming from one possessing great practical experience. I have felt it right to mention the point, although it was the only adverse criticism we met with at any of the places visited, upon the admittedly general excellence of the entire system.

I am bound, however, to add, that since the return of the Deputation I have seen it stated in print that the Corporation of Birmingham commenced a Sanitary Depôt about four years ago, at which were erected four Destructors, two Concretors, and a Carboniser; and that these were abandoned after a short trial. This statement was so entirely at variance with the experience of the Deputation and myself in other places, that I immediately instituted an inquiry, and have received the following explanation from Mr. Fryer, viz. :—The Depôt was started in the very centre of Birmingham, exactly opposite, and beneath, the large General Hospital. To it were brought great

quantities of excreta, which were mixed with ashes in order to make a crude manure. The Concretors were used for the purpose of concentrating the excreta, the action being as follows, viz.: the products of combustion from the Destructor furnaces were brought into surface contact with the excreta, and the resulting vapour mingling with the former ascended the chimney. The process was submitted to the judgment of Dr. R. Angus Smith, F.R.S., who thoroughly examined and approved the same, and it was carried on for a time without nuisance of any kind; presently, either from wilfulness or carelessness, or both, the workmen in charge ran a quantity of raw excreta into the *hot flues*, whereby it was subjected to a process of baking, which gave rise to noxious effluvia in the surrounding neighbourhood.

The trustees of the hospital took alarm and resisted any further continuance of the works at the Depôt. In a short time the Concretors were suppressed; then the Carbonisers, and finally the Destructors. A prejudice was thus created against the whole proceeding, but that no objection

applied to the Destructors proper is proved by the fact that they were subsequently re-worked, and have been in constant use up to the present day.

Feeling considerable anxiety upon the subject, I felt it my duty to obtain further evidence from a perfectly disinterested and independent source, and I accordingly applied to Dr. Alfred Hill, the accomplished Medical Officer of Health for Birmingham, who has permitted me to quote the following response, dated 6th April, 1881 :—

"Borough of Birmingham,

"Health Department.

"There is some truth but much error in the "account you have received of the use of Fryer's "Destructors and Carbonisers in Birmingham. We "have used them both and found them to do their "work in a satisfactory manner; but owing to their "being situated too near to our principal hospital, "the empyreumatic odour of burning vegetable "matter was much complained of by the officers

"and inmates of the institution. On that account "we discontinued the use of the Carbonisers "altogether, and of the Destructors for a time. "We have, however, resumed the use of the latter, "and are using them now; they work perfectly "well, and we have had no complaints from the "hospital since they were used alone. I believe "the Carbonisers would be quite unobjectionable "if only properly situated; in our case the situa- "tion was most unfortunate.

"As regards the Destructors only, I may say "that we use at one of our wharves the boiler "furnaces in place of them, so that if you have "need of steam for any purposes you might with "much saving of expense utilise your boiler "furnaces. We find that by means of the em- "ployment of our Destructors and our furnaces we "have reduced our refuse by as much as $\frac{5}{6}$ths or "$\frac{6}{7}$ths, so that where we formerly carted or boated "away six or seven loads of material we now have "to remove into the country only one load. This "is a very satisfactory result when the difficulty "and expense of disposing of the material are "considered."

Thus far we have spoken of the reduction of mineral matter by means of the Destructor; it now remains to mention another branch of the system by which vegetable refuse and garbage may be converted into charcoal by a process of slow combustion; this is effected by means of what is termed

The Carboniser.

The Carboniser is also the invention of Mr. Alfred Fryer, and lest it may be thought his description might be coloured by a pardonable partiality for his own creation, I append that of Mr. Alfred W. Morant, the Borough Engineer of Leeds, and President of the Association of Municipal and Sanitary Engineers, read at the Annual Meeting held at Leeds, 27th May, 1880.

"The Carboniser consists of a group of brickwork cells and furnaces, each cell having its own distinct furnace alongside of it. It is 26 feet long, 12 feet wide, and 15 feet 6 inches high, tied together with iron rods and angle irons.

" The refuse to be carbonised is fed into the apparatus at the top, the loose cover of the cell being removed for that purpose, and immediately replaced ; within the brickwork cells are hung, by means of cast-iron plates fixed in its walls, a series of cast-iron plates, or eaves, touching the walls along their top edges, but standing free from the walls some inches along their lower edges. These plates are arranged to overlap one another, and form a continuous sloping ledge or eave, winding round and round the cell in a kind of spiral. Near the bottom of the cell the spiral eave finishes with a fire block eave, the lower edge of which rests on a wall dividing the contents of the cell on one side, from the hot gases of the fire, which are admitted to it on the other side.

" The refuse is fed into the cell until it forms a solid mass within the well of the spiral eave, being withdrawn at the bottom as it gets sufficiently charred, but it is not mobile enough in its nature to rise up again either underneath or behind the eaves, so that a space is there left forming a

continuous flue in connection with the chamber behind the fire-block at the bottom of the cell, and up this flue pass the hot gases from the fire, heating the contents of the cell. At the top of the cell these gases pass through the damper frame into the vertical flue, and so into the main flue and thence to the chimney. The process undergone by the refuse is as follows: After being thrown in at the top of the cell it sinks gradually as it becomes closer packed, and as the finished charcoal is withdrawn at the bottom, it sinks, and continually comes in contact with hotter and still hotter plates until at the bottom of the cell it enters a chamber of nearly red hot fire-brick.

"No air is admitted during the process except a slight amount which reaches it from the flue behind the eaves, so that instead of being consumed it is charred. The cell terminates about two feet from the ground in a strong cast-iron plate, in which is an opening closed on the underside by a sliding door; this is opened at certain intervals (about 3 hours) for letting out a charge of charcoal into a small truck which is run in below the plate ready to receive it.

The furnace with fire grate and door is of ordinary construction, and within it a thick dull fire is kept up. Sight or peep boxes are provided to enable the flues nearest the fire to be cleansed, and similar peep boxes higher up allow a view on to the backs of certain of the cast iron plates for the purpose of seeing that they do not become over-heated.

"Though the cast-iron plates are bolted to the walls, or through the walls to one another, they are removable if need be without pulling down any of the brickwork.

"The charcoal, which comes out of the carboniser red hot, is cooled in a char-cooler, by passing through a revolving cylinder, over which cold water is continuously streaming, and is sifted as it issues from the outer end. This cooler is also driven by the steam engine which works the mortar pans.

"Each cell deals with about fifty hundredweights of refuse in every twenty-four hours, and the fuel required for the furnaces is sifted from the contents

of the dry ashpits, it not being necessary to purchase any.

"The cost of an establishment with one six-celled Destructor, a Carboniser with eight cells, boiler, steam engine, two mortar pans, cooler, chimney shaft, and buildings, is about £4,500.

"No nuisance of any kind is experienced in the vicinity of the depôts, and this system of dealing with the refuse of towns appears to be gaining ground."

The Deputation saw the Carboniser at work at Burmantofts and other places, and will, I think, endorse the above description in every minutiæ; not only is the charcoal produced without cost for fuel, but the manufactured material equals in point of excellence the ordinary commercial article, and sells readily at 20s. per ton.

The sifting of the coarser portions of the dry ashpits for supplying the only fuel needed to work

the Carboniser, from the finer portion (which sells for 2s. 6d. a load), is effected upon sliding or moving screens placed in an acutely slanting manner, and by this simple device a great deal of profitless labour is saved, and the work conducted without brutalising the operators :—The revolving cylinder referred to by Mr. Morant was seen in motion, and the Deputation admired the ingenious contrivance by which the charcoal was separated into a coarse and a fine product by mechanical means. I append a sketch of this cylinder.

The quantity of market refuse carbonised in one month last year at Burmantofts is stated to be 204 tons, and as we were informed by the attendant that 6 tons of refuse produce one ton (or thereabouts) of charcoal, it follows that the quantity of the latter amounted to 34 tons. In one experiment made it was found that 100 cabbages will yield 8 lbs. of charcoal.

The system of carbonising market refuse is not altogether new; formerly it was produced in

large cast-iron retorts, but the quality of the charcoal was inferior, and the expenses of production high, owing to the necessity for frequent repairs to the brickwork in which they were set; moreover, there was a great waste of heat, as the apparatus had to be entirely opened before the charcoal could be withdrawn. In Holland, the sanitary authorities at Kralingen, near Rotterdam, have adopted the Carboniser, which appears to have been very favourably reported upon, great stress being laid upon the advantage of employing a continuous process, and thus avoiding waste of time and heat; also on account of the great economy effected by the modern furnace, the price of the charcoal produced by the Carboniser, compared with that from the old iron retorts being in the ratio of 1 to 25, owing to the cost of fuel; thus, the old furnaces (retorts) required 25 hectolitres of coke to produce 25 hectolitres of charcoal, equal to 6s. 3d. per cubic yard; whilst with the new (Carboniser) the same quantity of coke will yield 125 hectolitres of charcoal, at a cost of 3d. per cubic yard. Stronger testimony cannot be afforded, and the

Dutch reporter is amply justified in asserting that "the system is to be commended for its healthiness, cleanliness, simplicity, and economy."

Amongst the many uses to which charcoal may be applied none is more desirable than that of purifying coffins and graves, and should the Commissioners of Sewers adopt the Carboniser its product may be advantageously employed at Ilford Cemetery, where the enormous mass of decaying humanity may, as the grounds become more and more crowded, require some oxydising and deodorising agents to prevent the evil consequences which sometimes arise from re-opening graves.

This charcoal industry is of more importance in places like Leeds, which has 40,000 common privies, 15,000 dry ashpits, 3,000 box privies (pail closets), 12,000 ordinary W.C.'s, and 2,300 trough closets, than it would be in London, where water-borne sewage removes the excreta.

When the charcoal is mixed with the contents

of the midden pails, which it immediately deodorises, it realises 30s. a ton if 25 per centum of night soil only be used, and 40s. per ton with double that proportion.

Having now described the constructive works necessary for carrying on the two chief branches included in this part of my scheme, I will, in the character of chronicler, assigned to me by the Committee, proceed to describe the places visited by the Deputation at which they witnessed both the Destructor and Carboniser in active operation.

ARMLEY ROAD.

This is one of two stations at which the Corporation of Leeds carries on the process of burning refuse. It is situated in the town of Leeds, not more than one mile west of its centre, in the midst of a dense population, surrounded by houses and shops of a respectable character, and deals with the refuse of about 60,000 persons.

It was built last year and has been in full operation since October.

The materials dealt with include house dust, street sweepings, market refuse, and human excrement from middens; the pail system being in use in many parts of this district.

At the time of our visit, the place was entirely free from smell, and although night soil in large quantities was mixed with house refuse, the carbonaceous matter in the cinders had completely deodorised them.

Nothing could have been more thorough or exhaustive than the examination at Armley Road. We saw the men delivering large masses of refuse, including house dust, market, and paved street sweepings, night soil from middens, &c., on the top of the Destructor; then watched the gradual sinking of the stuff into the service-holes, as the portions below were consumed; following this down to the front we witnessed the extraction of the coarser materials (pots, pans, glass, crockery, etc.), as well as the clinkers, from the furnace doors below, the opening of which gave pretty hot

evidence of the power expended in the cremation, without a grain of other fuel than that contained in the refuse itself; but the *crucial test* of all was, that when the smoke box, at the end of the boiler, through which all the fumes pass onwards to the chimney shaft, was opened, there was not the least odour; so completely had all organic matter been dissipated in the furnace. Again, when the clinkers and molten metal and glass, all fused together, were drawn, the only perceptible smell, and that very faint and momentary, was of a slightly sulphurous nature.

The fine dust deposited in the flues, and carried for some distance up the chimney by the gases and smoke, falls back into the "dust-chamber," from whence it is removed when necessary, and sold to farmers at 2s. 6d. per load. Large quantities of iron utensils, pots and pans, metal cases, tin, etc., fall to the front, and being raked out, and allowed to cool, sell for 20s. to 30s. per ton, as old metal.

It may be convenient to mention here that in

some of the places visited by the Deputation it was observed that a new commercial product of marketable value had been created by the use of the Destructor, viz.: the clinkers resulting from the process of burning the refuse are ground by heavy rolling mills into powder, which, when mixed with 25 per cent. of lime and a suitable proportion of water, is converted into a useful mortar, or cement, found to be very tenacious and hard from the oxide of iron and silicious matter derived from the clinkers; small hard bricks are also made from the same material. The making of this mortar costs 4s. 5¼d. per ton, inclusive of all labour and materials, and sells readily for 5s. to 5s. 6d. per ton; it will keep moist for 48 hours and can be "knocked-up" fresh for use when partially set like any other mortar. It is valued by local builders and much sought after. Each mill will make about 8 tons of mortar a day.

Specimens of the clinkers, cement, and brick may be seen at the Sewers Office, Guildhall.

The second station is in the district of Burman-

tofts, situate about two miles from the centre of the borough, in a North-easterly direction; it is termed the "Beckett Street Depôt;" in it are Destructor and Carboniser furnaces, and rolling mortar mills; which have been in constant operation for the last *four years.*

The amount of work done at Leeds will be seen by a glance at the following table handed to the Deputation by the obliging superintendent, Mr. Newhouse.

BOROUGH OF LEEDS.

REPORT of Night Soil, &c., removed during the Month of December, 1880, as compared with the Month of December, 1879.

When Removed.	No. of Middens emptied.	No. of Dry Ashpits or Tubs emptied.	No. of Boxes or Pails emptied.	Total.	Tons Removed.			Total.
					Night Soil.	Dry Ashes.	Rubbish.	
December, 1880	3,686	9,640	52,344	65,670	6,026	3,256	2,752	12,034
„ 1879	3,248	10,335	50,016	63,599	5,830	3,645	2,071	11,546
Excess, 1880	438	—	2,328	2,071	196	—	681	488
„ 1879	—	695	—	—	—	389	—	—

"During the past month 782 loads of rubbish have been destroyed at the Beckett Street Depôt, being an average of 34 tons 3 cwts. per day for 25 working days; 31 tons of rubbish have been used for fuel for the Carboniser.—172 tons of market refuse have been carbonised. At the Armley Road Depôt 1,067 loads of rubbish have been destroyed, being an average of 45 tons 3 cwts. per day for 26 working days."

These two stations suffice for the bulk of the scavengering wants of Leeds, which has an acreage of 21,600, a population of 326,000, and a rateable value of £1,100,000.

I may here note the fact, as giving one of the the many instances observed by the Deputation of the intelligent forethought and enterprising spirit of our Northern provincial brethren, that the erection of a station at either end of the Borough has proved a great economy, by saving the otherwise heavy outlay for the cartage of refuse from one end of Leeds to the other; an example we shall doubtless profit by, when occasion offers.

The following extract from the Report of the Sanitary Committee of the Council of the Borough of Leeds, showing the total cost of the works at Burmantofts, furnishes some useful information :—

"The Committee have fully examined into the cost of the Apparatus at Burmantofts, and the quantity of material which has been dealt with, and submit to the Council the following figures and particulars with regard to the matter :—

"CAPITAL ACCOUNT.

	£	s.	d.
"Cost of Brickwork, Engine, Boiler, Mortar Mill, Destructor Cells, Carboniser, and other Apparatus and Implements; making new road,* providing shed to cover Apparatus, &c., &c., at the Burmantofts Depôt	4,270	0	0
Royalty to Patentee - - -	150	0	0
*Value of Land and Chimney Shaft -	1,460	0	0
	£5,880	0	0

*Some of the items of the Capital Account refer to the purchase of Land and other matters not necessarily connected with the burning process.

"REVENUE ACCOUNT.

Expenditure.	£	s.	d.	Receipts.	£	s.	d.
To Interest on £5,880 at 4 per cent.	235	4	0	By Mortar	200	0	0
„ Sinking Fund	58	16	0	„ Charcoal	100	0	0
„ Labour for twelve months	627	18	0	„ Scrap Iron	15	0	0
					315	0	0
„ Lime	40	0	0	„ Balance	990	18	0
„ Depreciation, at 5 per cent., covering repairs	294	0	0				
„ Gas, Water, Rates, &c.	50	0	0				
	£1,305	18	0		£1,305	18	0

"ESTIMATED QUANTITY OF MATERIAL DELIVERED AT THE DEPÔT.

	Per annum.	
Rubbish burnt in the Destructor at the rate of	9,923	tons
Used in the Carboniser for fuel	750	„
Market Refuse	1,800	„
Total	12,473	tons

"It will be observed that the cost of dealing with 12,473 tons of Rubbish and Refuse delivered at the Burmantofts Depôt has been after the rate of £990 18s. per annum.

"The Committee have considered the question of extending the process by erecting apparatus in other parts of the Borough, and submit the following information to the Council.

"Estimated quantity of Rubbish and Refuse collected throughout the Borough, according to the returns of the present Night Soil Contractors, per annum - - -	35,577	tons
Allow one-fifth for overweight given in Returns - - -	7,115	,,
	28,462	,,
Destroyed at Burmantofts - -	9,923	,,
Leaving provision to be made for dealing with - - - -	18,539	tons

"In order to make provision for dealing with the whole of the Rubbish and Refuse, the Committee

are of opinion that the erection of two additional six-celled Rubbish 'Destructors' in suitable districts would be ample to meet all requirements for a considerable time to come ; and suggest that one 'Destructor' should be erected in the neighbourhood of Armley Road, to deal with the Rubbish collected in the Mill-Hill and West Wards, and the Headingley, Burley, Kirkstall, Armley, and Wortley Districts ; and the other 'Destructor' in the neighbourhood of Lady Pit Lane to deal with the Rubbish collected in the South, Hunslet, and Holbeck Wards.

"The estimated cost of continuing Mr. Fryer's Patent, at the Burmantofts Depôt, and erecting Apparatus in other districts, as proposed, is as follows :—

For Destructor, Ironwork, Brickwork, Chimney, Platform, and Shed, &c., for two additional Depôts - -	£5,400
Land - - - - - -	2,000
Royalty - - - - - -	2,000
	£9,400

"The Committee, after making minute inquiry into every detail, are satisfied that it would be advantageous to the interests of the Borough to continue the use of the Apparatus at present erected at the Depôt at Burmantofts, and to extend the process by the erection of additional works in the manner suggested."

"Dated this 9th day of September, 1878."

"JOHN WOOD, CHAIRMAN."

"The Council, being satisfied that the treatment of the refuse by the method here recommended by the Sanitary Committee offered a very large pecuniary advantage over the previous method of carting the refuse to tips, voted the requisite grant of money, and the new works at Armley Road were at once commenced."

In strict chronological order the works at Burmantofts Station ("Beckett Street Depôt,") should have been described first, but as those at Armley Road deal with a district, which in the

number of its inhabitants approximates very closely to those resident in the City of London, the latter have been selected in illustration of the general proposition, as affording a better means of comparison when estimating our own requirements.

From Leeds the Deputation proceeded to Bradford, and were favoured with the presence of Mr. Alderman Blackburn, the Engineer [A. J. Cox, Esq.], and the Medical Officer of Health [H. Butterfield, Esq.], who gave much valuable information.

BRADFORD.

The Sanitary depôt is situated in open ground, and unlike that of Armley Road has no surrounding houses. At the time of our visit one Destructor, consisting of six cells, was at work, and although but recently constructed was disposing of 37 tons of waste material a day ; house refuse and dust only are burnt at this place, the midden contents being sent into the country in railway trucks, during the night time, to farmers, who pay sixpence a load for it, exclusive of carriage. We were informed,

that so satisfied were the Sanitary Authorities of the efficiency of the Destructor, that a second set of six cells was in contemplation ; it being calculated that with twelve cells one-third of the whole of the town refuse, consisting of 140 cart-loads a day for a population of 200,000, could be cremated. I call attention to the fact, that this is the second instance adduced in this Report in which the success of the Destructor has justified an extension of its operations. As before mentioned the chimney shaft is 180 feet high, and the Borough Engineer thought this would suffice for a third Destructor, or 18 cells in all ; the six cells now in use are worked night and day, and four men only are required for the purpose ; the place was very clean, and entirely devoid of offensive odours.

Warrington, population about 33,000, was next visited, for the purpose of inspecting the Depôt at Longford, situated within a drive of the borough ; the special interest attaching to this place arises from the fact that here the old and new systems of treating refuse, &c., may be seen in operation side by side ; not only are the Destructor and the Car-

boniser at work upon house, trade, and vegetable refuse, but the excreta are dealt with by the introduction of machinery of novel construction and automatic action, the perfection of which may be estimated when it is mentioned, that enormous quantities of fæcal matter and urine are evaporated, *in vacuo*, and reduced to powder and utilised without offence of any kind.

The "Patent Double Effect Dryer," a drawing of which I append, is the apparatus employed in this process.

Under the old system much nuisance was created, and the parties interested were threatened with legal interference; upon which the new processes were substituted, and although, as we were informed, the malcontents employed detectives to watch the same, they were removed after a time, when all fear of annoyance, or injury to health, had vanished.

WARRINGTON,

LONGFORD DEPÔT.

The following description of the Works and the modes adopted in the manipulation of the Materials is abridged from the Report of THOMAS LONGDIN, Esq., Borough Engineer, July, 1879.

OLD SYSTEM.

"The matters included may be classified as under :—

(*a.*) Ashes, &c., collected in ash tubs.

(*b.*) Street sweepings, including vegetable and animal refuse.

(*c.*) Pail contents.

"The contents of ash tubs are formed in heaps

on the ground, and after having all iron and other saleable materials taken therefrom, are fired and allowed to burn about six weeks. The cinders are then thrown against upright sieves for the purpose of separating the fine ash, which is removed to the sheds and formed into dams or pits for the reception of the pail contents.

"The vegetable and market sweepings and refuse are also formed into heaps and mixed with the contents of middens, forming an inferior manure, which is offered for sale at a low price.

"The contents of the pails are emptied into the dams or pits with alternate layers of fine ash and pail contents, and the mixture is allowed to remain until the liquid is absorbed by the fine ash and becomes of such consistency that it can be removed. It is then sold as manure.

"The total weight of material brought to the depôt during the twelve months, from March 26th, 1878, to March 25th, 1879, has been :—

(*a.*) Ashes, &c., collected in ash tubs and from ashpit middens	6,319	Tons
(*b.*) Street sweepings, including vegetable and animal refuse	1,141	„
(*c.*) Pail contents	4,100	„
Total	11,560	Tons

"The system was found objectionable for the following reasons, viz. :—

"1st. The burning of ashes to reduce bulk and produce fine ash for mixing purposes gave rise to offensive effluvia, which caused complaints from the Warrington Rural Sanitary Authority.

"2nd. Owing to neighbouring towns having adopted the pail system, and there being more competition in the sale of a mixed manure, the price had to be reduced 25 per cent.; the stock, however, increased to such an extent that there was often 2,000 tons on hand, for which no adequate shed accommodation existed.

"3rd. In consequence of the manure having

to be mixed outside, and remaining such a long period on hand, it lost much of its valuable qualities, as the liquid drains away, and besides causing loss of weight, threatened to become a serious and dangerous nuisance to the neighbourhood."

"In view of these difficulties the Sanitary Committee referred the matter to the Borough Surveyor, who recommended the process of **cremation**, and gave the following description of the means by which he proposed to carry out this object:—

NEW SYSTEM.

"*(a.)* **Ashes, &c., Collected in Ash Tubs.—**

"These will be discharged on the ground level, and lifted by an elevator and cast into an automatic cinder screen, which will separate the material into two portions, viz., fine ash and coarse material.

"The fine ash will be discharged at a point sufficiently high that it can be shot into a cart

without labour, afterwards removed and mixed with such portion of pail contents as will furnish a manure sufficient to satisfy the local demand, and similar in quality to that at present sold.

"The coarser portion will be discharged at the top of the Destructor, which is a form of furnace made to destroy and reduce any refuse material that contains only a small portion of combustible matter.

"The heat generated by the combustion will pass under and through a multitubular boiler, and generate steam for furnishing the power required for working the whole of the machinery.

"The clinkers from the Destructor will, if not required for other purposes, be passed into a mortar mill, which will reduce it to powder that can either be sold as sand, or made, by the addition of lime, into an excellent and tenacious mortar.

"*(b.)* **Street Sweepings, including Vegetable and Animal Refuse.—**

"This refuse, being sweepings mainly from the markets and streets, will be discharged on ground level, and raised by an elevator to a platform and passed through the **Carboniser**, a furnace which converts all vegetable material into charcoal.

"The fuel required for heating this furnace consists of a portion of the sifted cinders from the ash tubs.

"The charcoal produced is a very powerful deoderant, and it is proposed to use a portion of the same in each pail previous to its leaving the Depôt, to deodorize the matter collected, and the remainder will be sold for such purposes as it is used for.

"*(c.)* **Pail Contents.—**

"The contents of the pails are emptied on the ground level into a covered tank, and are conveyed by means of a chain pump into an elevated air-tight store tank.

"Having been mixed with a small portion of acid to fix the ammonia, the thicker portion of the material settles to the bottom of the tank. Any odour that may be disengaged from its contents will be conveyed by a pipe to the Destructor furnace.

"The thin part of the contents of the tank is drawn off into two evaporators, which are tall cast-iron cylinders, each containing near its lower end a drum-shaped heater, precisely resembling a multitubular steam boiler.

"These cylinders are partially filled, and the heating drums are covered with the thin liquid, steam is introduced within the heating drums, and the liquid becomes partially concentrated.

"When the contents of these cylinders is sufficiently concentrated and have lost, by evaporation, the greater portion of their water, they are drawn off into the 'Firman's Dryer,' and the thick portions of the pail contents which settle in the store tank, are also admitted into the 'Dryer.'

"This machine consists of a steam-jacketed horizontal cylinder, traversed by a steam-heated axis and by steam-heated revolving arms, and furnished with scrapers to keep the inner surface of the cylinder free from accumulations of dried excreta.

"The pail contents is admitted into the Dryer at the consistency of thin mud; after treatment it emerges as a dry powder, resembling guano in appearance and quality, and realising a price commensurate with the nitrogen and phosphates it contains.

"It has been abundantly proved by the experience of all other towns upon the pail system, that the production of waste combustible material is not sufficient to furnish heat to evaporate the pail contents in ordinary machines, and to such the purchase of a portion of coal has been inevitable. A very important feature in 'Fryer's' patents is that by the before-named arrangements more than one-half of the fuel is dispensed with, and so the collected combustible refuse suffices.

" The method of working this important mode of concentration may be thus summarised: The vertical concentrating vessel first described is supplied with steam direct from the boiler, and the 'Firman's Dryer' is supplied in like manner. The steam and vapour, however, which are driven off from the concentrating vessel and the Dryer, instead of being allowed to escape into the air or being condensed by cold water, are used to furnish heat to the large or main concentrating apparatus, which is kept boiling at a low temperature. This is effected by conducting the boiling below atmospheric pressure in a vacuum, which is maintained by an air pump, attached to the steam engine. This larger vessel is in fact a vacuum pan. The apparatus is so connected with tubes and valves that the 'Firman's Dryer' may also be worked under vacuum if necessary. The whole of the vessels are enclosed. All the steam generated is condensed, and the odour given off during the process is all passed through the Destructor fire and absolutely destroyed. From the time the liquid material enters the store tank, there is no opportunity for odour to escape into the air, as it is

kept closely under cover, until it finally emerges as a dry powder. The manure made by this process closely resembles guano in appearance and quality, and will be worth from £3 to £6 per ton, dependent upon analysis.

"Mode of Operation and Explanation of Plan Annexed.—

"The carts containing ash from ash tubs will, after passing over weighing machine, discharge at point marked A, for elevator to lift to Destructor.

"The carts containing street sweepings, &c., will discharge their contents at point marked B for elevator to lift to Carboniser.

"The vans containing pail contents will, after being weighed, discharge at point marked C, and, after the pails are emptied, they will be passed on to the washing shed, where both van and pail will be thoroughly and effectually cleansed by steam power, and previous to the pails being placed in the van, they will receive a certain amount of the charcoal before named.

" The washing of the pails is a very important feature, as pails received from infected houses, if allowed to be sent out in an imperfectly washed state, are likely to propagate disease.

" After the vans have been reloaded with clean pails they pass on, and, being reweighed, proceed to further collection.

" The water required for the machinery and Depôt generally, is proposed to be taken from the brook forming western boundary of land. An open reservoir will be formed alongside the brook, and the water pumped therefrom into a cistern, placed in such position that the water will gravitate to any part of the Depôt.

" The whole of the power required for the works will be furnished by a twenty-horse-power engine.

" Product, Old and New Systems.—

" During the past twelve months 4,596 tons of mixed manure have been sold, the value being

£868 12s. 2d. Amount of profit realised upon the sale of midden contents £29 16s. 7d. Stock left on hand, the estimated value of which is £169 5s., making a total value of the year's product £1,067 17s. 2d.

" On the proposed new system, with the quantity of present collections received at the Depôt, the following will be the saleable product :—

3,200 tons Mixed Manure,
1,000 ,, Sand,
700 ,, Charcoal,
290 ,, Concentrated Manure,

which represents an estimated money value of £2,260.

" Working Expenses.—

" The cost of working the Depôt during the past 12 months, under the old system, has been £560 6s. The working expenses on the proposed system will be about £468, showing a decrease of £92 in favour of the new mode of disposal.

" It is only fair to note that when the maximum weight of materials is brought to the Depôt, the expense, if manipulated under the old system, would be £810, whereas the same quantity will not increase the working expenses of the new system.

" General Remarks.—

" The general effect of the new system will first and foremost be to suppress nuisance.

" All accumulations of offensive matter will be removed, and the odour arising from the burning of the mineral matter will likewise disappear.

" Street sweeping and other refuse materials will not have to be carted to 'tips,' and the valuable materials collected will be utilised to the fullest extent.

" The operations at Longford will be conducted without the purchase of any coal, and they will be so arranged that, in case of any interruption to

the new process, the old one can be continued efficiently, and at much less cost than at present."

The Deputation were enabled to verify these statements by the evidence of their own senses; they saw in one portion of the yard an immense pile of refuse slowly smouldering away, and giving off fumes reeking with offensive gases, waiting for removal under the old regime, whilst in the new part of the same yard they witnessed the Destructor and Carboniser at work without the faintest approach to nuisance. The works at the Depôt are not yet completed, and this afforded us the opportunity of comparing, on the spot, the relative value of the two systems; when the transition is accomplished the method of "tipping" will be entirely abandoned.

Other places were seen and examined, en route, by the Deputation, such as sewage works, disinfecting chambers, hospitals for contagious diseases, markets and slaughter-houses, &c., &c., but these, not being germane to the special object of this Report, I must pass over.

Reverting to the subject in hand, I think it must be conceded that we have before us a new line of departure of singular promise ; and that, by patiently waiting for its full development, we have been spared the risk and cost of failure ; even if we cannot claim the honour of being the pioneers of a system destined in the opinion of all competent and disinterested sanitarians, to supersede the present vicious methods of disposing of house-refuse ; here, as in all things advanced for the benefit and protection of our fellow men, there should exist no such thought as *finality*, and it behoves those who possess the *power*, to find the *means*, so soon as they are convinced that any alteration of practices condemned upon the judgment of their responsible advisers, show, in their inception, the germs of success.

In this spirit I submit that the time has arrived when the Commissioners of Sewers may adopt the system of cremation, as herein described. As a tentative measure I would recommend the erection, at Lett's Wharf, of a ten-cell Destructor, boiler, steam engine, shafting, and two rolling mortar

mills, in connection with the chimney shaft already standing. These, Mr. Fryer informed us, would cost about £3,000, inclusive of Royalties to the inventors, but exclusive of such buildings as may be required to protect them from the weather, which will amount to about an equal sum. (See estimates in other places at pages 53 and 54).

Without trenching upon the province of your Engineer, I may suggest, that in providing for the delivery of house refuse on the top of the Destructor, about 17 feet from the ground level, the space required for the incline, as obtains at Armley Road and other places, may be saved by the adoption of an "elevator" of sufficient power to raise a whole cart-load at a time.

Until the Destructor has been got into working order, and the attendants have become familiar with the same, I do not advise the construction of a Carboniser, although the near completion of the new Vegetable and Fruit Markets will furnish ample materials for its profitable use.

An eight-cell Carboniser and Charcoal Cooler will cost £1,500, exclusive of other buildings.

Concurrently with these works, I recommend that a permanent Sanitary Depôt be established upon the vacant site cleared by the Artizans' Dwellings Scheme, 1875, in Golden Lane, which is admirably adapted for the purpose, and which can be obtained at a very moderate cost, subject of course to the consent of H.M. Home Secretary, and the understanding that corresponding accommodation for workmen's dwellings be provided elsewhere.

On this spot should be erected a chimney shaft not less than 170 feet high; a double Destructor, of 12 cells; a Carboniser; steam power; mortar mills; a carcass crusher; two Firman's dryers; and other appliances requisite for treating condemned meat, and fish, &c. (which will be described in Part II. of this Report). The ground should be enclosed by a brick wall of sufficient height to secure privacy, and no unauthorized person allowed on the premises. This plan, properly executed, and efficiently super-

vised, would provide for all the house and trade refuse, market sweepings, and condemned meat, and fish, furnished by the City of London; the requisite works could be carried on without annoyance or injury to anyone, chiefly during the night time, and the money saving to the ratepayers would represent many thousands a year; the wages of over 100 people would be included in this economy, and the cost, and wear and tear, of horseflesh, carts, barges, and water carriage, &c., would also very sensibly contribute in augmenting the amount saved; lastly, and not least, the miserable spectacle described at page 17, would no longer haunt the consciences of Honourable Commissioners.

Exception may be taken to the suggested *night labour*, to which I would reply that the less works of the kind we are considering are obtruded before the public gaze the better, there being at all times an amount of sentimental opposition which outweighs sober judgment and honest criticism; and as the City of London is almost deserted during the night time, the incon-

venience, which to some extent is unavoidable in all sanitary processes, will be felt by comparatively few persons whose susceptibilities are, possibly, not so keen as those of their more fortunate neighbours. Moreover, it should not be forgotten, that the work is one of necessity, and that, whether we like it or not, the time must inevitably come, and is fast approaching, when every local authority will be compelled to commit its own nuisances in its own district.

Thus far I have endeavoured to answer your Reference to me, detailed at page 9, as fully and faithfully as the exigencies of space, and the limited time at my command, have permitted. Avoiding many minor details, and as far as possible a reiteration of facts once stated, upon the principle *ex uno disce omnes;* I will therefore conclude this part of my Report, dwelling for a moment upon the course pursued by the Deputation in their investigations.

From direct inquiry from the officials employed by the various urban and suburban Sanitary Authorities who have adopted the system of cremation, they satisfied themselves of the economy effected by it as compared with the older methods, and are of opinion that its establishment in the City of London will effect an enormous saving in the charges now incurred under the existing regime.

In one of the places above indicated, they learnt that the Sanitary Authorities had saved £5,000 a year out of a previous outlay of £17,000 a year, the old cost being £17,000 as compared with £12,000 under the process of cremation ; in another district they were told, that with a population of 60,000, the whole business was conducted by five men, who were employed at a cost of £9 per week, and that with this plant upwards of 1,000 cart-loads of house refuse were treated.

The convictions arrived at from a careful inspection of the various processes in active operation,

were materially strengthened by the disinterested testimony of various municipal authorities, including the Mayors of Leeds, Bradford, and Warrington, Aldermen and Chairmen of Sanitary Committees, Medical Officers of Health, Borough Engineers, and the persons actually employed in the business, all of whom combined the freest information with the most genial courtesy, and who, without exception, spoke in the highest terms of approval.

It may seem invidious to particularise where all were so kind, but I cannot resist mentioning the name of A. W. Morant, Esq., C.E., the Borough Engineer of Leeds, who, regardless of personal risk, being in feeble health, devoted the whole of one bitterly inclement day to the purposes of the Deputation, and who subsequently furnished both the Chairman and myself with valuable drawings and details in connection with our subject.

From the evidence thus collected, the Deputation came to the unanimous conclusion that the system

recently inaugurated is sound in theory, and desirable in practice; that it has already passed beyond the experimental stage, and, that it offers enormous advantages upon sanitary grounds, and is not to be despised for its commercial results; not only did they see a work consisting of poisonous and disgusting elements dealt with, and satisfactorily disposed of, without nuisance of any kind, but learnt that products having a marketable value can be, and are, produced without any infraction of true hygienic principles, whilst at the same time they may have the effect of materially reducing the expenses.

In corroboration of these views it may be added that Fryer's Destructors, &c., have been or are being supplied to the following places, viz.:—

Leeds:—Bradford:—Manchester:—Warrington: Rochdale:—Stafford:—Bolton:—Birmingham:— Blackburn:— Rotherham:— Derby:— Bury:— Holland:—Kralingen:—France.

A number of other towns have also decided to adopt them, including Nottingham, and others are in treaty.

PART II.

In a Report I had the honour to present to you in June, 1877, I entered fully into the *"Various methods of dealing with Meat seized as unfit for human food in the City of London,"* wherein were offered some novel proposals for relieving you of the difficulties occasioned by the increasing bulk of material condemned in the markets and slaughter-houses within your jurisdiction.

The question was considered under the following distinct propositions :—

1st.—The mode of dealing with diseased and putrid meat when first seized by the Inspectors.

2nd.—The best means of conveying it to the place at which it is to be destroyed or otherwise treated.

3rd.—The place at which it is to be deposited.

4th.—The most economical and efficient process for its utilization or destruction.

5th.—The commercial value of the three principal constituents of meat as seized in the market, viz., flesh, fat, and bone, in their raw state, for purposes in the Arts and manufactures only, estimated at current prices.

6th.—The application of the products of the said meat after its complete reduction into fibre, bone, and fat, by mechanical or chemical processes, based upon the known worth of the contained ammonia, phosphorus, *and* fat, *the two former as fertilizers, the latter for use in the Arts, as calculated from scientific data.*

At that date the average quantities of meat seized annually between 1861 and 1873, both years inclusive, amounted to **90** tons, whereas the quantity for 1874 was **194** tons :—for 1875, **153** tons :—for 1876, **238** tons :—for 1877, **199** tons : for 1878, **181** tons :—for 1879, **258** tons :—for 1880, **273** tons :—the average for the last three years being **237** tons per annum.

Pari passu with this experience is the natural increment in the business done at the great markets at Smithfield, as will be seen by the statement of toll received; this does not, however, represent the whole matter, since the markets at Aldgate and Leadenhall cannot be included, there being no machinery by which their aggregate transactions can be estimated.

TOTAL WEIGHT OF GROSS SUPPLY SENT TO CENTRAL MEAT MARKET.

	YEAR.	WEIGHT. Tons cwt. qrs.	TOLL. £ s. d.
Year ending	1870	142,038 6 3	15,782 0 9
" "	1871	147,491 3 2	16,387 18 2
" "	1872	154,045 17 2	17,116 4 2
" "	1873	151,366 17 3	16,818 10 10½
" "	1874	157,628 18 1	17,514 6 5½
" "	1875	164,450 8 0	18,272 5 4
" "	1876	176,162 17 0	19,573 13 0
" "	1877	197,631 16 2	21,959 1 10
" "	1878	195,993 10 2	21,777 1 2
" "	1879	212,987 14 0	23,665 6 0
" "	1880	218,790 6 3	24,310 0 9

In the same Report was pointed out the crude and wasteful way by which it was sought to utilise the products of the meat seized, and some improvements were suggested therein.

From that date to the present time you have proceeded upon the old lines, and an annual contract has been made under which you have disposed of an essentially valuable material at a fraction of its worth, owing to the limited competition on the part of the contractors who have not felt disposed to erect proper plant for working a business which may be taken from them before they could recoup themselves for their outlay. Nevertheless, in spite of this, you have received in cash during the years 1878, 1879, and 1880, the sum of £2,608, or an average of £869 annually. This amount, calculated at 5 per cent., represents a capital sum of upwards of £17,000.

As before explained to you, the commercial value of the condemned material consists of **fat, meat-fibre,** and **bone.** Of these the most important

is the fat, and as I purpose dwelling chiefly upon this product, I do not hesitate to reproduce here some of the arguments I advanced in my Report of 1877.

The **fat** is the commodity most sought after, and will realise prices according to its condition ; that taken from *diseased* animals is probably contaminated to a slight extent only, owing to the fact that animals when discovered to be out of health are disposed of as rapidly as possible, to save the cost of their feeding, so that their ailments, as observed post mortem, are chiefly those of the acute inflammatory type, since they are not ill long enough to produce any very extensive change of structure, beyond the rapid wasting of the muscles from want of nourishment, whilst the fat from the meat seized for *putridity* alone will not be sufficiently altered in its composition to materially lessen its value for commercial purposes. Apart from these considerations it must be remembered that every particle of meat seized will have been disinfected before it leaves the custody of the Inspectors.

The percentage of fat in all meats cannot be correctly estimated; so much depends upon the season of the year, the method of feeding, the peculiarity of breed, the age of the animal, and their condition of health, especially in cows and sows during and after lactation: invariably more fat is obtained from mutton than from beef, weight for weight, both in good and bad meat.

In healthy and well-fed sheep the fat often exceeds 40 per cent. of the total weight of the meat as sent to market, and in fully-fed beef 25 per cent. It is true that these quantities are not forthcoming in the meat seized by the Inspectors; but this, apart from the question of *diseased* animals, arises from the circumstance of the butchers having cut away a large portion of the fat before the meat is removed from their premises, a practice I recommend should be forthwith prohibited, since it cannot be safely used for human food; and it would be wiser, in the interests of the public health, to insist upon the whole being delivered up to the Inspectors, even should that course involve an equitable claim from

the salesmen for whatever additional loss they may sustain in consequence, which might be fairly and generously considered.

The difference between the fat as it exists in the meat when first seized and that issuing from the extractor after prolonged steaming is in favour of the latter for several reasons.

In the first place the fat as collected from the butchers is not pure, having attached to it a proportion of connective (or cellular) tissue, blood, blood-vessels, and lymphatics, and in order to disengage the fat globules from these the mass is minced by tallow dealers before it is melted, after which it is strained through sieves whilst still in a state of fusion; the *débris* is then subjected to heavy pressure to squeeze out the remaining fat, and sold as 'greaves' for the food of dogs, pigs, and poultry.

On the other hand, the fat obtained from the extractor will be free from all extraneous material, and therefore weight for weight will be much more valuable than the fresh fat.

It may, however, be thought that the putrid condition of the fat in the condemned meat will destroy its utility, but practically this is not the case, since the odours arising from the peculiar rancidity all fats exhibit after they have been exposed to the air for a certain time (resulting from decomposition, and the formation of volatile 'fatty acids') is easily dissipated by heat, and all impure smell is entirely and instantly absorbed by the steam in the cylinder. The fat, in addition to its being thus purified, would not be otherwise materially altered in its constituents, although it is alleged by some of our best chemists that all fat undergoes some minute molecular change each time it is melted; the change, however, is inappreciable, and of no moment.

The chief outcome of the Report above quoted was the establishment of the tanks therein recommended for the treatment of putrid meat, &c., by immersion in a chemical solution, or bath, a system which, I may be pardoned for saying, has been of great service, by enabling the Inspectors to disinfect and deodorise the bulk of the meat seized

before it is taken to the factory of the contractor. Moreover it renders the meat so uninviting to the sight, and so permanently nauseous to the taste, that all possibility of tampering with it, for fraudulent purposes, is prevented.

As this bath has been imitated in other places, and the formula for its preparation largely inquired for, I may add, that I have somewhat modified its composition, and instead of that described in the Appendix of my said Report of 1877, I now employ the following :—

DISINFECTING BATH.

Chloride of Calcium [Na Cl :] -	2 cwts.
Chloride of Sodium [Ca Cl :] -	½ ,,
Protosulphate of Iron [Fe SO_4 :]	1 ,,
Carbazotic (or Picric) Acid [C_6 H_3 N_3 O_7 :] - - -	2 lbs.
Water [H_2 O :] - - -	300 galls.

I find this solution more active and durable than the former one, having frequently preserved large

quantities of putrid material free from smell for several weeks. The only precaution needed is to *cover the meat with the fluid;* and with game and lighter articles, plucks, &c., it will be found necessary to keep them beneath the surface by a heavy iron grating, or some similar contrivance.

If the bath be in use for some time, it is necessary to add a little more picric acid occasionally, because the meat absorbs the colouring matter rapidly, and relays of material are not sufficiently stained with yellow, especially the fat, unless this addition be made.

I have been led to allude to this bath in order to refute an objection which has been urged respecting its chemical action upon the quality of the fat. As a matter of fact, it has no more action upon the physical structure of the fat globules than common salt would have upon lard, or butter; and as all the ingredients are soluble, whatever saline particles are communicated can be easily dissolved out by simply washing the fat in tepid water during its clarification after collection. In con-

nection herewith it must be remembered that this fat should not, under any circumstances, or any disguise, be used as food for man, its legitimate application being with candle makers, soapmakers, perfumers, and manufacturers of various sorts of lubricants, &c.

After an exhaustive inquiry and repeated experiments upon a large and small scale into the quantity of fat found in the meat seized, including offal, I speak advisedly in putting it at not less that 15 per cent. ; of this probably only two-thirds have been extracted hitherto by the existing methods of manipulation, but with the appliances described in subsequent pages, I have no doubt whatever of the correctness of my estimate. I am prepared to find it contested, by persons whose interests may dictate, the depreciation of the value of the condemned meat, and will therefore dwell for a moment upon a point or two in proof of my assertion. In the first place, by far the greater proportion of meat seized by the Inspectors consist of the finest American-fed beasts, and swine, brought over in carcass in prime condition, but become putrid

from the failure of refrigerating materials; secondly, I contend that by the process of comminution of the bones in the "**Devil**" (herein depicted), at least 3 per cent. of additional fat will be obtained from that source alone.

Assuming then that *fifteen per centum* of fat will be procured from the entire bulk of meat seized as unfit for food [including offal and game], and taking this, approximately, in this and succeeding years, at 300 tons, it follows that **forty-five tons** of fat will be forthcoming, which, at an average price of only £30 per ton, will represent the sum of £1,350. Here again I am quite within the mark as you will perceive by referring to the account of sales made at the Foreign Cattle Market, Deptford, in 1872-3, when the fat sold on four occasions yielded £35, £32 19s., £32, and £30 per ton respectively, the average price being £32 4s. 9d. per ton.

The **Meat-fibre** ranks next in the order of value; it is that portion of the meat remaining

after all the fat has been extracted :—When dried, in a suitable apparatus, at 212° Fahr., until only 8 per cent. of moisture remains, it will represent 13 per cent. of the whole quantity, as ascertained by carefully conducted experiments. It has been long held in estimation by farmers as a manure, and is largely used, as such, in those countries in which animals are slaughtered for their fat, and hides, only. As an average result of several determinations, by the combustion process, I have found it contain 10·80 per cent. of ammonia, which calculated at *fifteen shillings per unit* per ton equals a value of £8 2s. per ton, for this element alone :—

Ammonia is a compound of nitrogen and hydrogen ($N.H_3$), and exists in the products of the decomposition of all animal matter :— Organised substances as they decay convert their nitrogen into ammonia, and, as this conversion is accomplished but slowly, their fertilising properties are especially applicable to those crops which take some time to complete their growth :—

It follows from the above calculation that at

13 per cent. the meat-fibre resulting from 300 tons of material will amount to 39 tons, and this at £8 2s. per ton will realise £315 18s.

It only remains to say a few words about the **Bones**:—I estimate the quantity of bones in the Condemned Meat, taking it all round, at 10 per cent. :—and as wet bones sell for £5 per ton, and nothing will be lost of either their organic or inorganic constituents, we shall add, by the new process, £150 to the manurial value of the meat-fibre yielded by 300 tons.

It would be superfluous to descant upon the influence of bones upon vegetation, mainly, but not exclusively, from the phosphates of lime and magnesia they contain ; but it may not be so generally known that their stimulating and nourishing effects last longer than artificial manures, on account of the comparative insolubility of these phosphatic salts ; and that, therefore, they are pre-eminently adapted to mix with the meat fibre, which possess the same durability, for the reasons

given above. Another advantage of mixing the two arises from the saving of machinery and labour involved in separating and adapting the bones for use in the arts, which, to admit of an appreciable margin of profit, requires steam-driving power, circular saws, &c., &c., and must be done upon a very large scale.

Summing up the results of dealing with the **fat, meat-fibre,** and **bone,** we arrive at the following financial conclusions as to the value annually of these materials in the 300 tons of Condemned Meat, viz.:—

45 tons of Fat, at £30 per ton -	£1,350	0	0
39 tons of Meat-fibre, at £8 2s. per ton - - - - - - -	315	18	0
30 tons of Bones, at £5 per ton	150	0	0
	£1,815	18	0

or **£946 18s. 0d.** more than the average receipts for the years 1878-79-80, and **£1,155 2s. 4d.** more than was paid by the contractor for the years 1879 and 1880 (the amounts for the latter being **£684 11s. 11d.** and **£636 19s. 5d.** respectively).

The magnitude of this subject demands serious consideration, and I submit the subjoined table for your information.

QUANTITY OF MEAT CONDEMNED IN THE CITY OF LONDON.

	YEAR.	WEIGHT. Tons	cwt.	qrs.	Percentage of bad to good Meat.
Year ending	1870	56	3	1	0·039
" "	1871	59	2	0	0·040
" "	1872	87	5	2	0·056
" "	1873	79	14	3	0·052
" "	*1874	193	18	2	0·122
" "	1875	153	1	1	0·093
" "	1876	238	2	2	0·135
" "	1877	198	19	0	0·100
" "	1878	180	18	0	0·091
" "	1879	258	4	3	0·121
" "	1880	272	19	3	0·122

* The cause of this great increase over the preceding year is due to the importation of meat from abroad which then commenced.

In all confidence, therefore, I submit to you the following propositions :—

i. That the Commissioners of Sewers determine the present contract at the end of this year, and take the treatment of Condemned Meat into their own hands.

ii. That in the meantime they erect a building as shown in plates 10, 11, and 12, annexed hereto.

iii. That a "**Devil**" (or carcass crusher), two of Firman's Rotatory Rendering Machines, Steam engine with driving-power, shafting, &c., be ordered of the patentees, Messrs. Manlove, Alliott, Fryer and Co.

The carcass crushing machine, which from its destructive properties I have christened after his Satanic Majesty, consists of two pairs of very powerful toothed rollers, about four feet long and of sufficient diameter, moving at different rates of speed, the lower rollers going faster than the upper in order to draw the meat through them (see plate) ; above is a hopper, into which the carcass of the animal to be crushed is lowered, and below are receptacles for the meat, properly enclosed.

A small one was tried about two years ago, at

my suggestion, by Mr. Fryer, and the following gives the result of the first experiment:—

"Nottingham, 9th July, 1879.

"The method of passing the meat through a "mill or 'devil,' in order to break up the bones as "explained by yourself, had been tried with strong "bones only, upon a powerful mill. It seemed, "however, desirable to make a more exact experi- "ment, and for this purpose I purchased a horse, "which, after being killed and skinned, was dis- "membered into large pieces and passed through "the mill. I have the satisfaction to report that "the experiment left nothing to be desired. The "masses, whether leg bones or vertebræ, ribs or "head, were grasped by the mill and passed "through with the greatest ease. Every bone "was broken into small pieces, and the rate of "grinding was such, that a whole animal was "passed through in 30 seconds. There would be "no difficulty in preparing a mill that would take "an animal entire. The process was not offensive, "and the product much less objectionable in "appearance than the flesh on entering the mill. "It was simply a mass of exaggerated mince-meat."

The Deputation saw this Devil at work at Farnworth, a few miles from Warrington, and, having witnessed its action upon a dead horse, will testify that Mr. Fryer's estimate of its power is not over-stated. Its chief use will be, the thorough comminution of the carcasses submitted to it, for the purpose of facilitating the next stage of the process, that of extracting the fat, which will be rendered more complete and effectual.

The flesh and bone thus prepared will, by mechanical arrangements on the spot, be transferred to Firman's Rotatory Rendering Machines.

These consist of horizontal cylinders, about 4 feet in diameter, and 13 feet long, and are entirely steam jacketed. Each cylinder is placed on its side, and a revolving axis, furnished with steam heated arms, and scrapers for keeping the interior clean, is caused to revolve by means of a Steam Engine.

The lacerated meat is introduced within the cylinder through a manhole on its upper side, the

lid is securely closed, and steam at a pressure exceeding that of the atmosphere is admitted within the casing or steam jacket. The contents are, by exposure to this temperature for several hours, (during which time the axis and arms are set in motion) acted upon by the steam.

The flesh is separated from the bone, and the fat is separated from the flesh and bones. When this process of digestion is completed, the pressure is withdrawn, the surplus steam conveyed to the condenser, and the fat decanted from the machine.

Afterwards, steam is again applied, but at a pressure of from 50 to 60 lbs. to the square inch. This serves not only to reduce the flesh, but also to dissolve the gelatine from the bones, and to soften them.

When this part of the operation is sufficiently performed, the tap is opened in a pipe leading from the Dryer to a Condenser, and the steam generated is entirely condensed by a jet of water.

The vapour is led away from the Condenser by means of an air-pump, and any vapours that may have passed the Condenser are forced into the boiler fire.

Thus the process of concentration is maintained below the atmospheric pressure, and the odour on desiccation is thus very materially diminished. Moreover, any leaks in the apparatus, should any exist, would simply *lead air into the machine*, and not permit its discharge into the outer air. The evaporation in the rendering machine is continued until the material is reduced to the required degree of moisture, 8 to 10 per cent. only remaining, the drying of the mass being facilitated by the constant agitation caused by the revolving arms.

Finally, an aperture beneath the Dryer is opened, and the residue, resembling a coarse brown powder, almost devoid of odour, is received into bags.

The finished article could henceforth be safely stored in casks and kept perfectly sweet until it was sold.

Two of the machines would be required. In one of them the process of digestion would be proceeding, while the desiccation would be performed in the other, and *vice versâ*. The steam for the apparatus would be generated from a Root's Boiler, a peculiarity of which is that it can be put into operation in the least possible space of time, and the boiler is able to sustain enormous pressures. The whole of the apparatus would be placed under one roof, and so arranged that the air required for feeding the furnace would be all drawn from that room, so that if any odour were generated from the storing of the material, or from any other cause, it could never escape into the air, but would all be destroyed by being passed through the fire. It would be essential that the operation be conducted near to a supply of water for condensation.

This method of dealing with the meat possesses the advantages that it is thoroughly efficient, and that it produces two materials of high value and ready sale. It does not attempt to multiply processes, and thus lead to the charge that a variety of products were obtained from the con-

demned meat, thereby giving its former owners a ground for a claim, but it entirely disposes of it with the least loss of time and expenditure of labour, and without the faintest chance of nuisance.

It may be remarked that the steam leaving the rendering machine is in all cases passed through the condenser, and there is no chance of offensive steam escaping from the building.

Each machine could certainly deal with three charges in 24 hours and each charge might weigh three tons. Thus, while the machines working moderately and in the day-time would readily dispose of a normal quantity of material, say one charge each machine, yet in case of emergency, when working day and night, they could cope with a very large quantity. When not in operation the apparatus would stand and suffer no injury, and in about an hour's time from the reception of a supply of material they could be in full operation. The same engine that drives the revolving axes will also drive the mill, the air-pump, and the

water pump, as well as some simple form of elevator for raising the meat to the mill.

Briefly recapitulated, the operation consists of three stages :—

i. The rendering of the fat at a temperature not exceeding 200° Fahr., and its decantation at the different levels where draw-cocks are seen on the drawing.

ii. After the fat has been removed, the cylinder is screwed down, and the heat raised to 300° Fahr., at which point it is maintained for from two to four hours, to soften the bones, and liberate the gelatine.

iii. The process of desiccation is then carried on at a lower temperature, say 175° Fahr., until not more than 8 or 10 per cent. of hygroscopic moisture remains in the meat-fibre and bone, when the cylinder can be emptied for a fresh charge.

These stages are completed in a comparatively little time, owing to the action of the "scrapers," which keep the material in constant agitation, thus insuring that the steam gets thoroughly incorporated with the mass being acted upon.

The cost of a "Devil," with Shafting, two Firman's Rendering Apparatus, Hoists, and Tanks, will be about £3,000, inclusive of Royalties, but not buildings.

"**Firman's** Desiccating and Rendering Apparatus" is the invention of an American whose name it bears, who, as far back as 1877, introduced it into this country, and on the Continent, where it was immediately adopted, and has since been in general use; as this gentleman has disposed of his proprietary rights I shall not be misinterpreted when I acknowledge the refined courtesy and attention accorded to me by Mr. Firman, or refer to his generous offer to erect one of his machines in the City of London, solely upon public grounds, and at his own cost. It was originally designed for the purpose of utilising many kinds of waste

products, such as human and all other kinds of animal excreta, urine, slaughter-house offal, dead carcasses, fish, poultry, and other refuse ; and it produces, from that which usually becomes an offensive nuisance, a material valuable as a highly-charged ammoniacal manure. It is also perfectly adapted for the treatment and rendering of all kinds of fats, producing tallow and lard of a particularly pure and fine quality.

The animal matters mentioned, which are usually employed in the manufacture of fertilisers, are dried, pulverised, and mixed at one and the same operation, so that when the material is discharged from the machine, it is then ready for the market *without any further manipulation or treatment, and the whole process is completed with a rapidity hitherto unattained by any other means.*

The apparatus creates NO NUISANCE WHATEVER. The steam liberated during the process of concentration is condensed, and the offensive gases are consumed in the furnace.

The cost of fuel and labour is very moderate,

while the temperature is not such as to drive off the ammonia.

While the employment of this apparatus and process will prove a source of large profit to private enterprise, it will also furnish a sure means, in a sanitary point of view, of solving the hitherto most difficult and perplexing problem of the proper disposal of the animal refuse and excrementitious matter of large towns and thickly populated districts.

The following Table illustrates one of the uses to which Firman's machine was put, by way of experiment, at Rochdale, three years ago :—

CAPACITY OF MACHINE ABOUT FOUR TONS.

WORK OF MACHINE.			ANALYSIS OF PRODUCT.				AVERAGE WORK.	
Quantity of Excreta or Pail stuff put into Machine.	Time.	Product (about).	Moisture remaining.	Ammonia.	Soluble Phosphate of Lime.	Alkaline Salts.	Value per Ton.	
45 cwt.	4½ Hours.	4½ cwt.	10 per cent.	7·29	4·50	4·50	£ s. 6 10	This Machine will dry 60 tons of pail contents per week, including all necessary stoppages.

As further evidence of its capabilities I also transcribe the following extract from a paper read at a combined Meeting of the North Western and Yorkshire Associations of Medical Officers of Health, held at Rochdale, February 1st, 1878, by J. Mitchell Wilson, M. B., Medical Officer of Health, Rochdale :—

In speaking of the "Rochdale System" of dealing with Excreta and House Refuse, Mr. Wilson said:—

Three years ago the Council decided that an endeavour should be made to dispose of the pail contents and fine ash in an unmanufactured state. This proved a very expensive proceeding. Since the middle of last year the manufacture on the original plan has been renewed, *with a very important additional means of concentrating the pail contents. This is effected by the use of a machine, the patent of Mr. Firman.* Into this machine about 30 cwts. of pail contents are poured through a very rough strainer, and 30 lbs. of sulphuric acid added. The water evaporated is cooled in a large condenser, and is afterwards passed into the river or retained for further use ; out of this condenser passes a pipe which is carried into a fan and an adjacent furnace, thus assisting the condensation, *and also preventing any nuisance in the works from the vapour or gases passing off from the machine.* The work now done by the machine is that in 4½ hours or thereabouts an average of 90 per cent. of water from the pail stuff is evaporated, and the product is found to be a manure in a dry state.

The following is a detailed analysis of the dried product after treatment by Firman's machine :—

ANALYSIS.

	Insoluble Silica - -	2·216
	Lime - - -	1·310
	Oxide of Iron and Alumina -	0·667
	Sulphuric Acid - -	4·450
(A.)	Phosphoric Acid - -	3·102
	Potash - - -	3·021
	Chloride of Magnesia -	1·910
	Chloride of Sodium -	5·120
	Sulphate of Ammonia -	22·191
		43·987
(B.)	Organic Matter - -	56·013
		100·000

(A.) Equal to 6·771 Tribasic Phosphate of Lime made soluble.

(B.) Containing 3·083 Nitrogen, equal to 14·534 Sulphate of Ammonia.

The next is an analysis of poudrette as it left one of Firman's machines at Rochdale :—

ANALYSIS.

	Insoluble Silica and Sand -	2·099
	Lime - - -	1·286
	Oxide of Iron and Alumina -	1·137
(A.)	Phosphoric Acid - -	2·695
	Potash - - -	1·719
	Chloride of Magnesia -	3·096
	Chloride of Sodium -	4.608
	Sulphate of Ammonia -	10·781
	Moisture - -	10·376
		37·797
(B.)	Organic Matter - -	62·203
		100·000

(A.) Equal to 5·813 Tribasic Phosphate of Lime.

(B.) Containing 4·240 Nitrogen, equal to 19·988 Sulphate of Ammonia.

Total Nitrogen equals 30·769 Sulphate of Ammonia, or about 8 per cent. (7·925) pure Ammonia.

ALFRED COOPER FRYER.

Grosvenor Square, Manchester,
November 12th, 1878.

At Longford Depôt the Deputation saw one of Firman's ingenious and interesting machines at full work in concentrating and converting into powder human urine and fæces, and they will support me when I declare that the building was faultlessly clean and perfectly free from odour.

In drawing these remarks to a close, I venture to hope you will find herein facts and figures which may induce you to regard with favour the changes they indicate, and commence for yourselves works which, whilst they will relieve you from any further reproach with regard to your treatment of Refuse generally, may be carried on with credit to yourselves as a Sanitary Authority, and advantage to those whom you represent.

Hitherto the profit yielded to the contractors for the Condemned Meat has been sadly discounted

by the interference of the Sanitary Authorities of the districts in which they carry on their works; and whilst we all know that a former contractor found it impossible to combat the difficulties of manipulating his material with incomplete and inefficient machinery, and was compelled to abandon it, I have reason to think that the present one will not be sorry to relinquish this part of his enterprise, *malgré* the pecuniary advantages he must derive from it at the price he pays for it. This contingency has ever been present to my mind, and I would urge it upon your earnest consideration, for without some prospective remedy I cannot conceive a more disastrous position for you to be in than to find yourselves suddenly called upon to cope with this matter.

I have now concluded the task allotted to me, which I trust may assist you in arriving at some definite course of action upon the subject it treats of; its appearance has been somewhat

delayed from a desire to avoid error, either of description or deduction, and from other circumstances for which I am not responsible.

I have the honour to be,

GENTLEMEN,

Your obedient Servant,

WM. SEDGWICK SAUNDERS.

Sanitary Department,

COMMISSIONERS OF SEWERS,

GUILDHALL, *April*, 1881.

LIST OF ILLUSTRATIONS.

1. Plan of Sanitary Works, Armley Road.

2. Section of Sanitary Works, Armley Road.

3. Plan, Elevation, and Cross Section, showing the general arrangement of a Six-celled Destructor Furnace.

4. Longitudinal and Cross Sections of Multitubular Boiler.

5. Half Elevation and Sections of Carboniser Furnace.

6. End Elevation and Longitudinal Section of Charcoal Cooler.

7. Plan showing Sanitary Works at Longford Depôt, Warrington.

8. Front and Side Elevation of Double Effect Dryer.

9. Longitudinal Section, End Elevation, and Cross Section of Firman's Patent Dryer.

10. Ground Floor Plan, showing general arrangement of Apparatus for treating Condemned Meat.

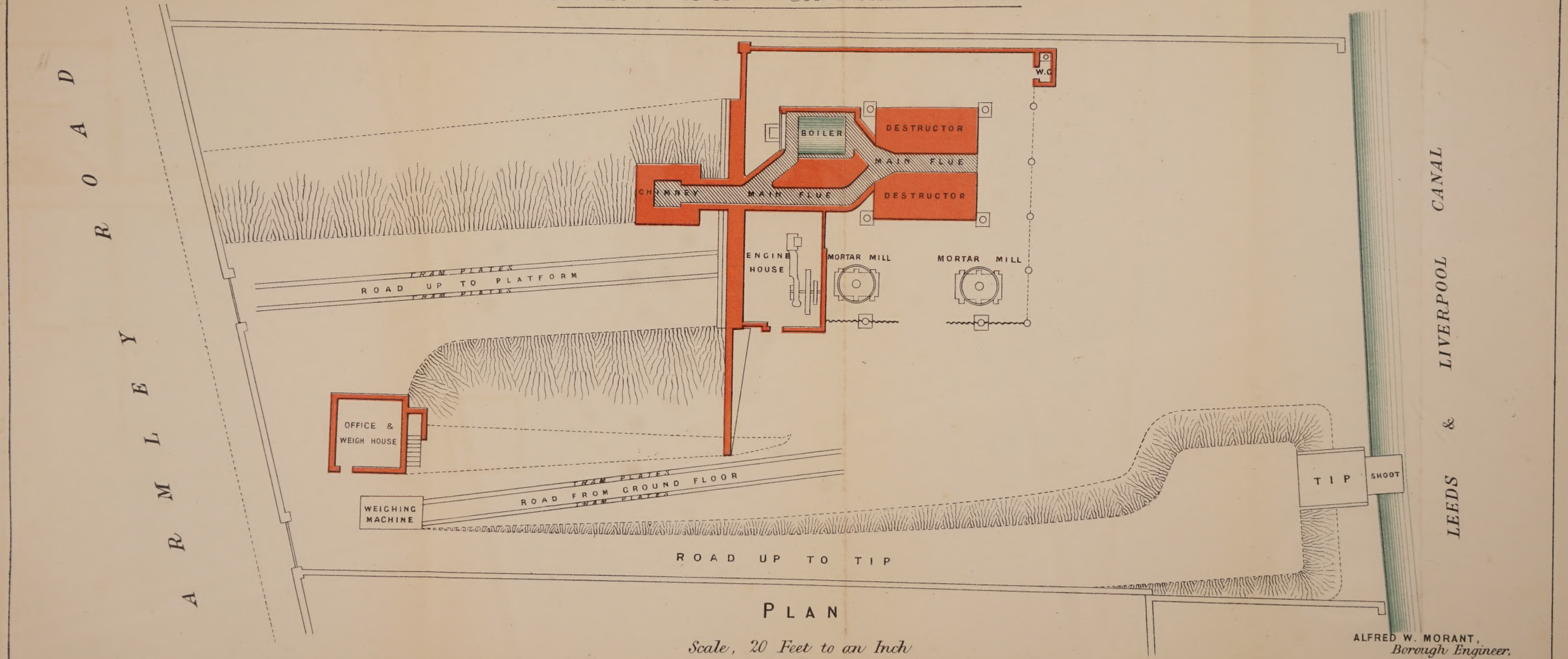
11. First Floor Plan, showing ditto.

12. Longitudinal Section, showing ditto.

13. Elevation of Devil or Carcass Crusher.

Charles Skipper and East, Printers, St. Dunstan's Hill, E.C.

ARMLEY ROAD SANITARY WORKS.



PLAN

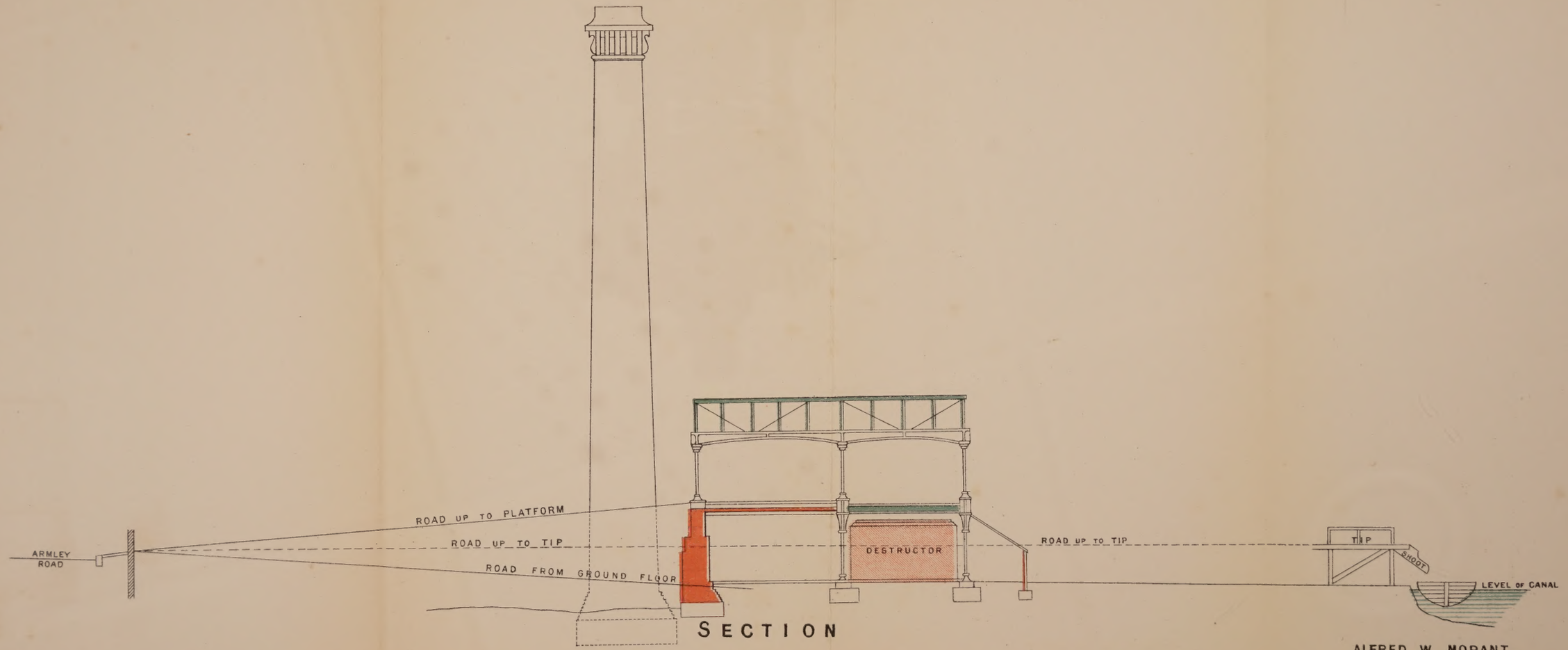
Scale, 20 Feet to an Inch

10 5 0 10 20 30 40 50 100 150 200

ALFRED W. MORANT,
Borough Engineer,
LEEDS.
17th Jan. 1881.

CHARLES SKIPPER & EAST, LONDON.

ARMLEY ROAD SANITARY WORKS.



SECTION

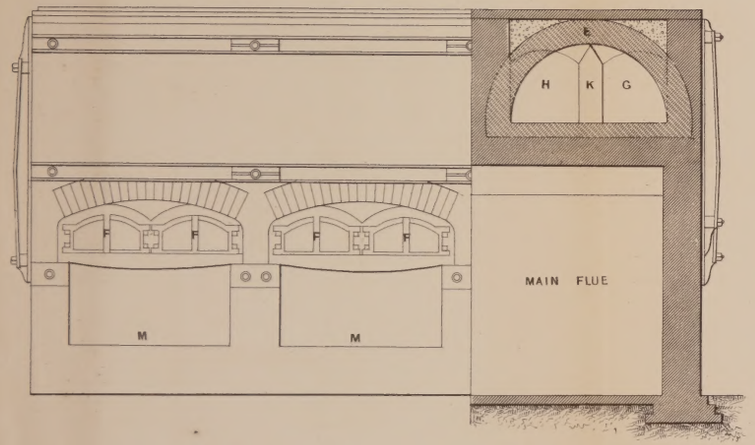
Scale 20 Feet to an Inch

10 5 0 10 20 30 40 50 100 150 200 Feet

ALFRED W. MORANT,
Borough Engineer,
LEEDS:
17th Jan. 1881.

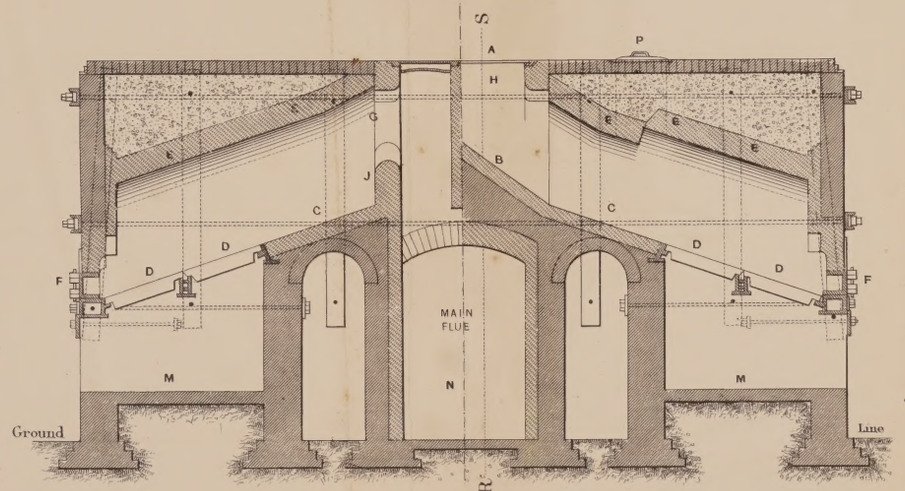
CHARLES SKIPPER & EAST, LONDON.

GENERAL ARRANGEMENT OF DESTRUCTOR FURNACE. WITH SIX CELLS.



ELEVATION.

SECTION AT R. S.

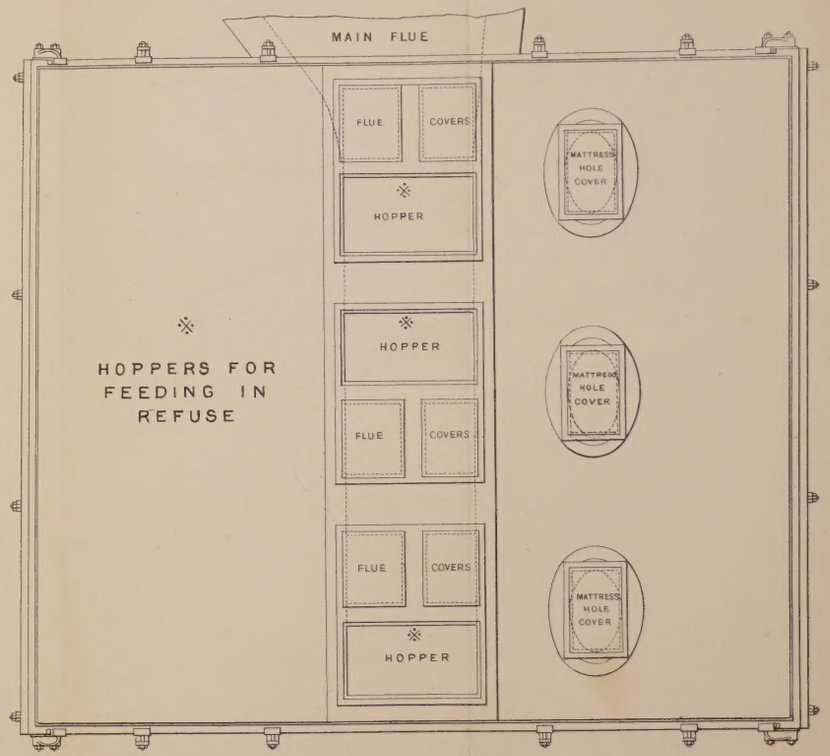


CROSS SECTION.

REFERENCE.

A *Refuse feed Opening*
B *Incline above hearth*
C *Drying hearth*
D *Fire Bars*
E *Reverberatory Arch*
F *Clinkering Doors*
G *Opening for Gases*
H *Opening for Refuse*
J. *Bridge to keep Refuse out of the Flue*
K *Wall to divide Gases from Refuse.*
M *Ash Pits*
N *Flue to Chimney*
P *Mattress Opening*

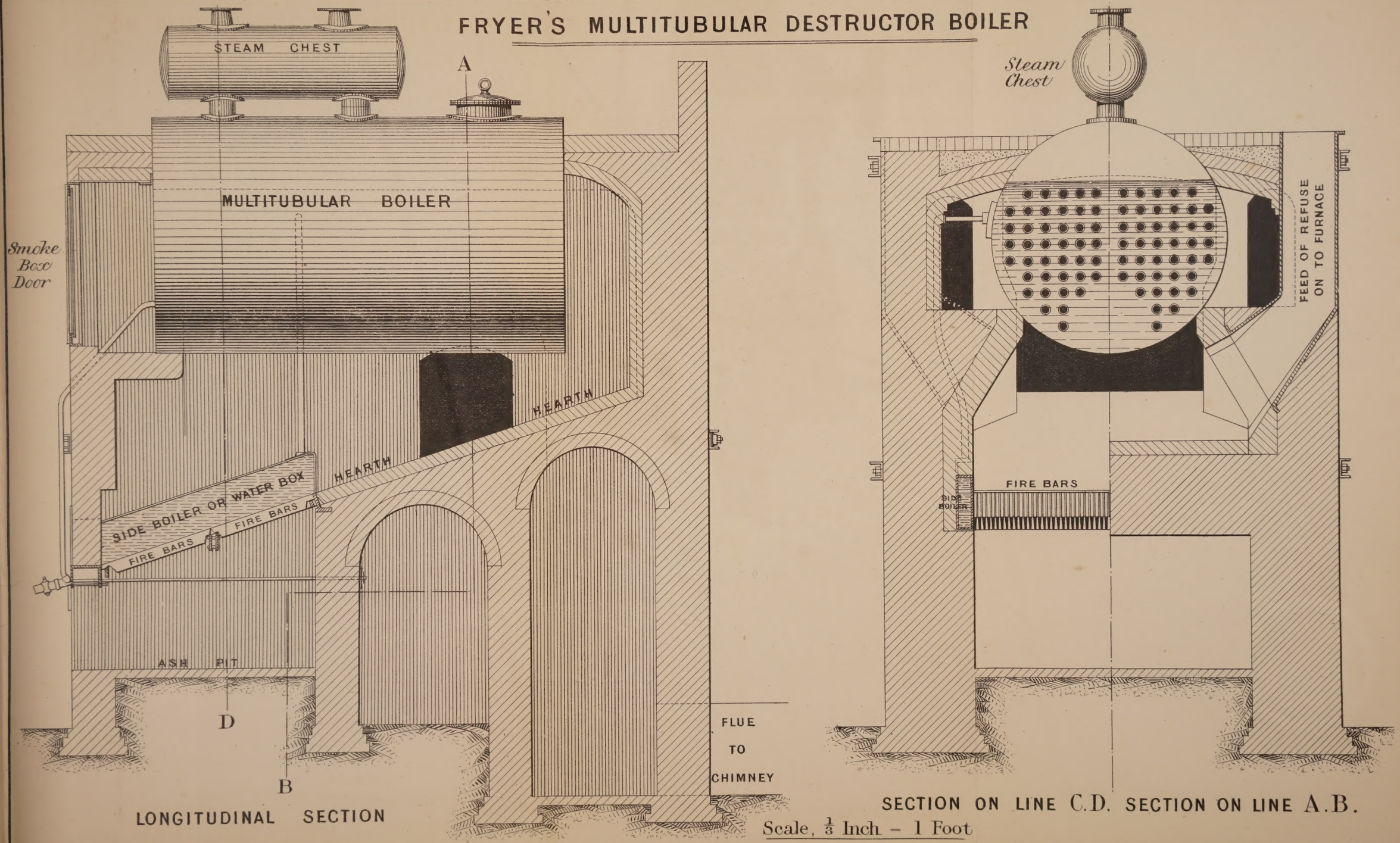
SCALE ¼ INCH TO ONE FOOT



PLAN.

CHARLES SKIPPER & EAST LONDON.

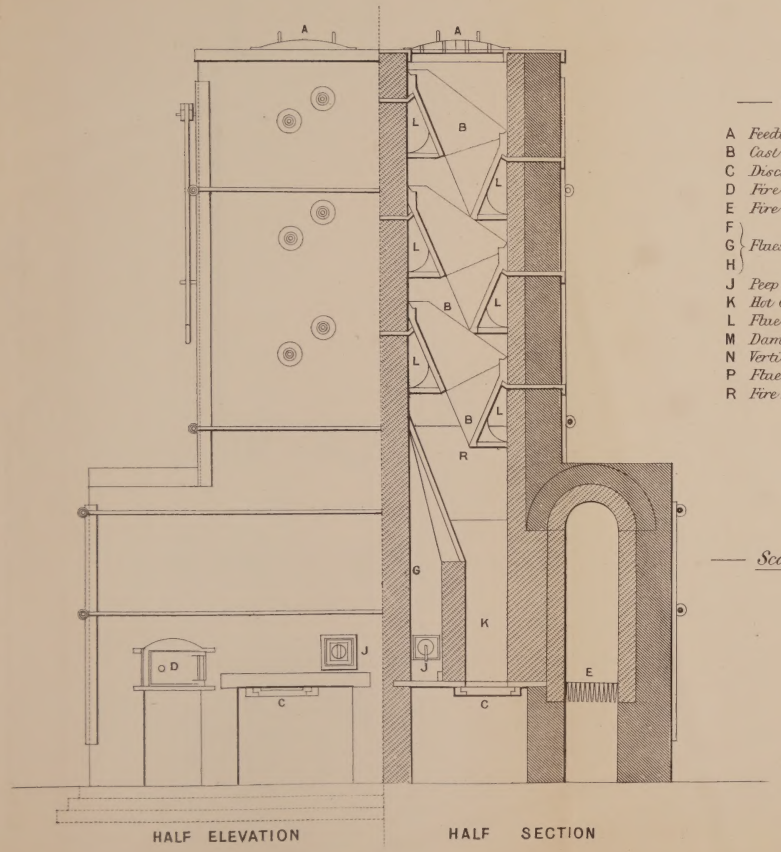
FRYER'S MULTITUBULAR DESTRUCTOR BOILER



Scale, $\frac{1}{3}$ Inch – 1 Foot

CHARLES SKIPPER & EAST, LONDON.

CARBONISER FURNACE

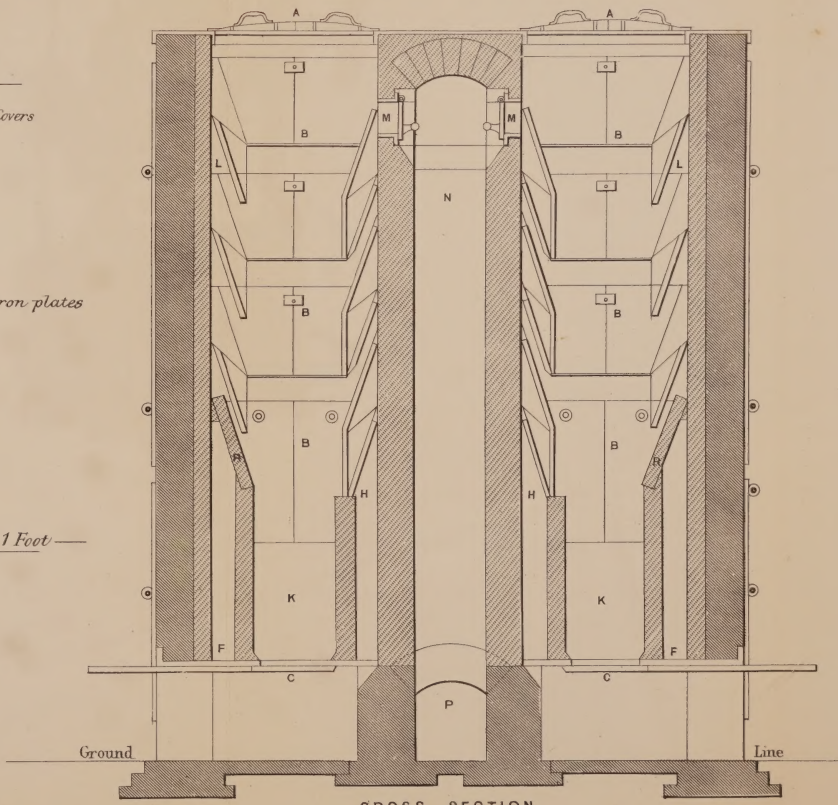


HALF ELEVATION HALF SECTION

REFERENCE

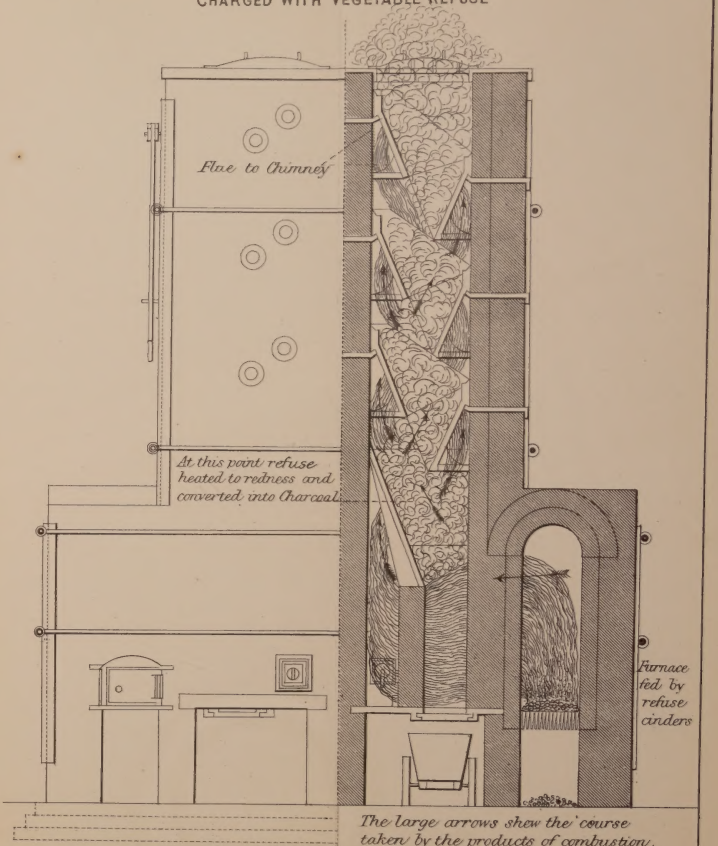
A *Feeding Holes with Covers*
B *Cast Iron Plates*
C *Discharge Door*
D *Fire Door*
E *Fire Grate*
F, G, H } *Flues*
J *Peep Box*
K *Hot Chamber*
L *Flue behind cast iron plates*
M *Damper*
N *Vertical Flue*
P *Flue to Chimney*
R *Fire Block*

Scale 3/8 Inch 1 Foot



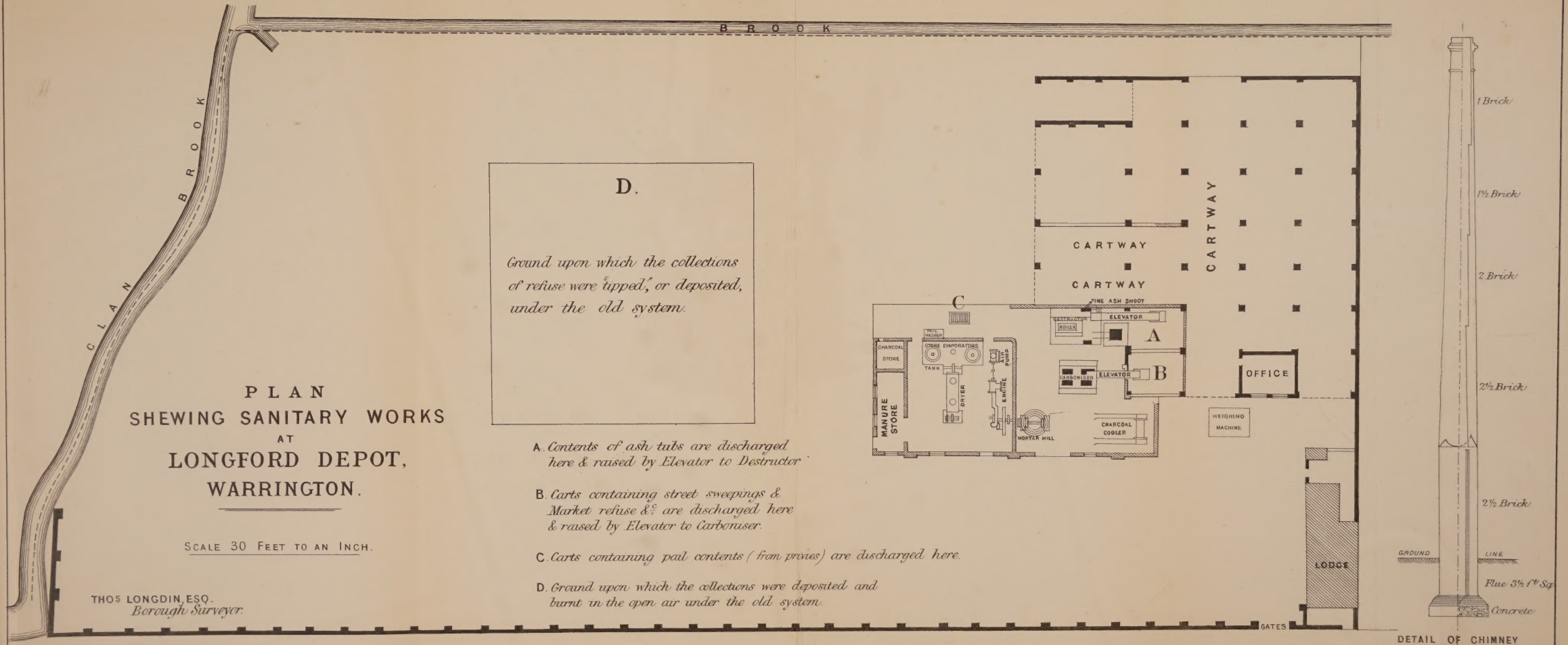
CROSS SECTION

VERTICAL SECTION OF A CELL
CHARGED WITH VEGETABLE REFUSE



The large arrows shew the course taken by the products of combustion, some of which also take the course shewn by the smaller ones

CHARLES SKIPPER & EAST, LONDON.



PLAN
SHEWING SANITARY WORKS
AT
LONGFORD DEPOT, WARRINGTON.

SCALE 30 FEET TO AN INCH.

THOS LONGDIN, ESQ.
Borough Surveyor.

A. *Contents of ash tubs are discharged here & raised by Elevator to Destructor*

B. *Carts containing street sweepings & Market refuse &c. are discharged here & raised by Elevator to Carboniser.*

C. *Carts containing pail contents (from privies) are discharged here.*

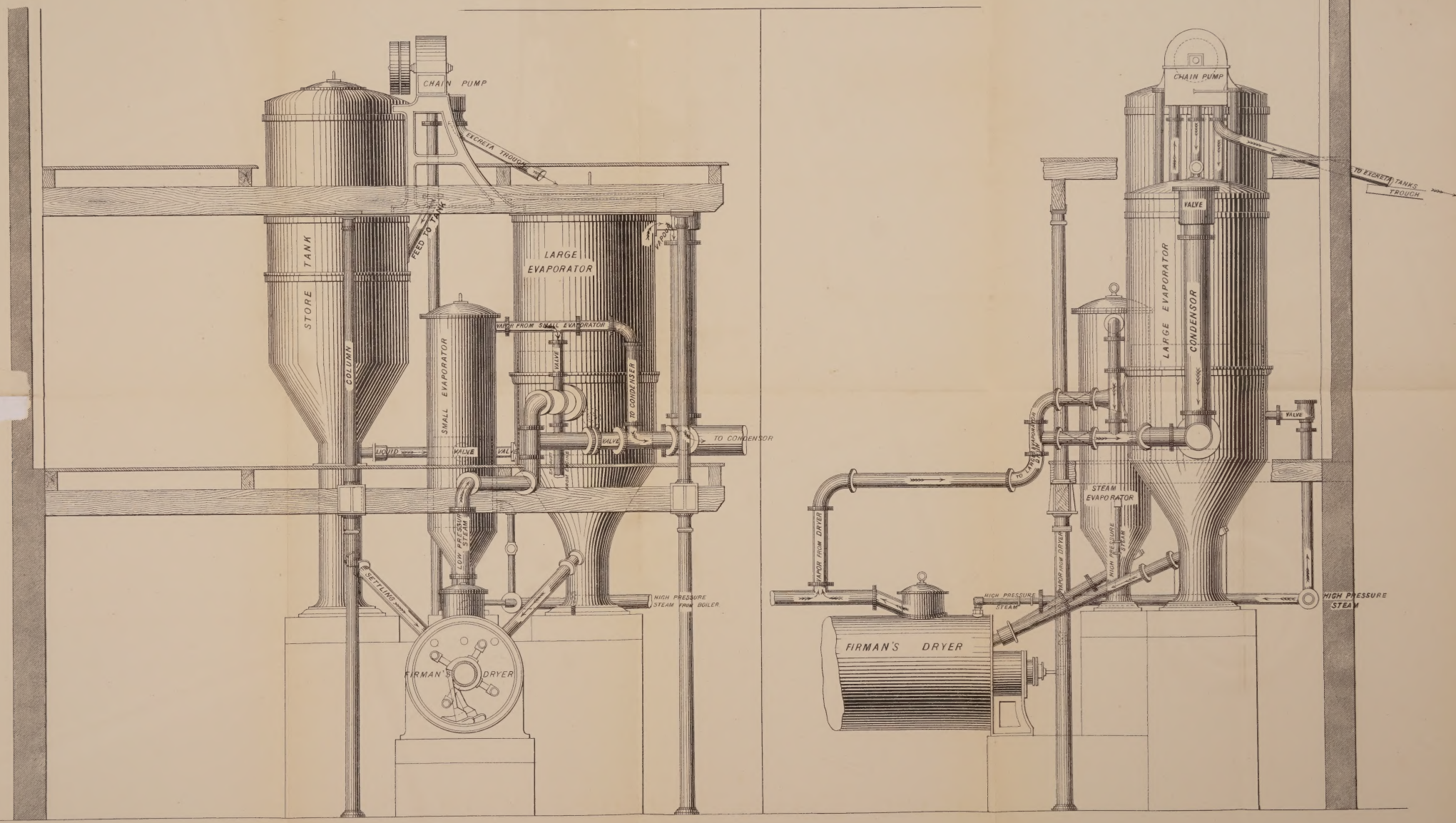
D. *Ground upon which the collections were deposited and burnt in the open air under the old system.*

DETAIL OF CHIMNEY
Scale, 20 Feet to an Inch

CHARLES SKIPPER & EAST LONDON.

LONGFORD DEPÔT.

PATENT DOUBLE EFFECT DRYER.

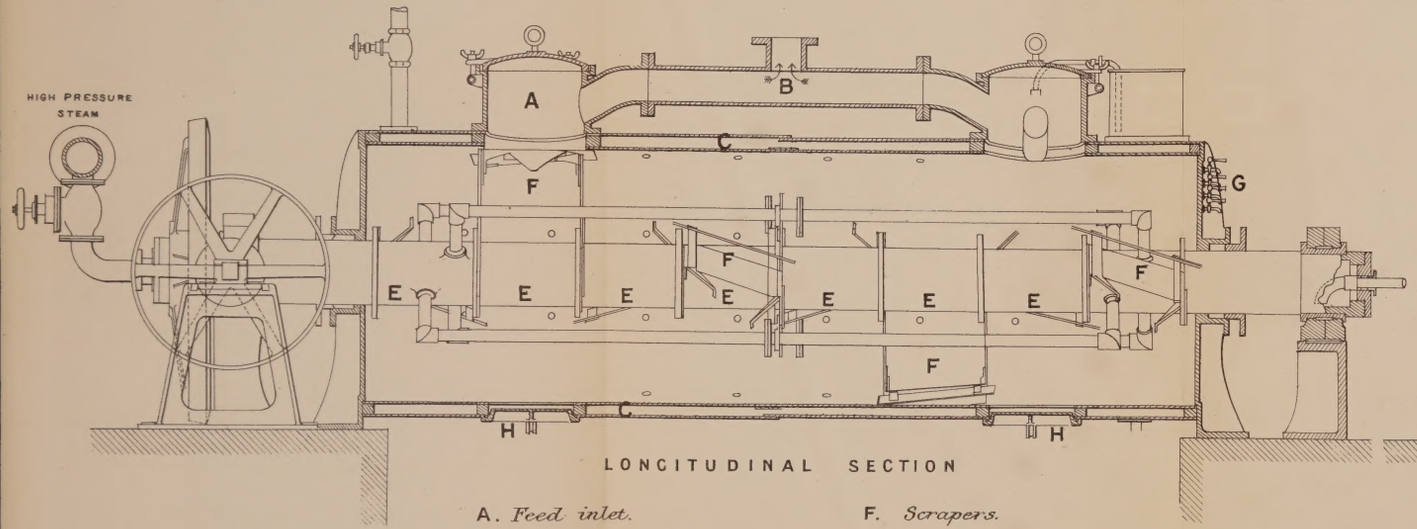


SCALE 3 FEET = 1 INCH.

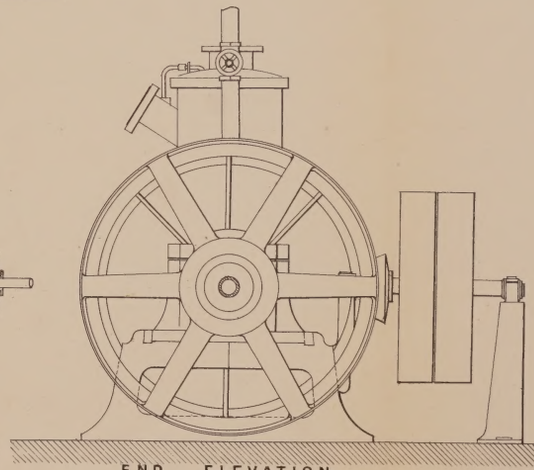
CHARLES SKIPPER & EAST LONDON

FIRMAN'S PATENT DRYER.

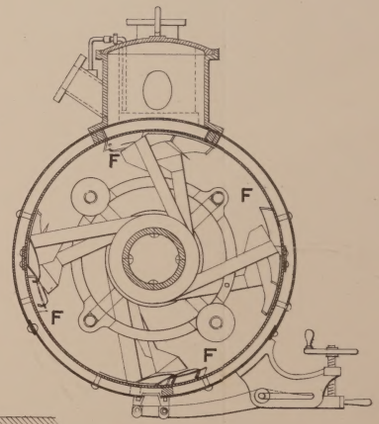
FOR CONDEMNED MEAT.



LONCITUDINAL SECTION



END ELEVATION



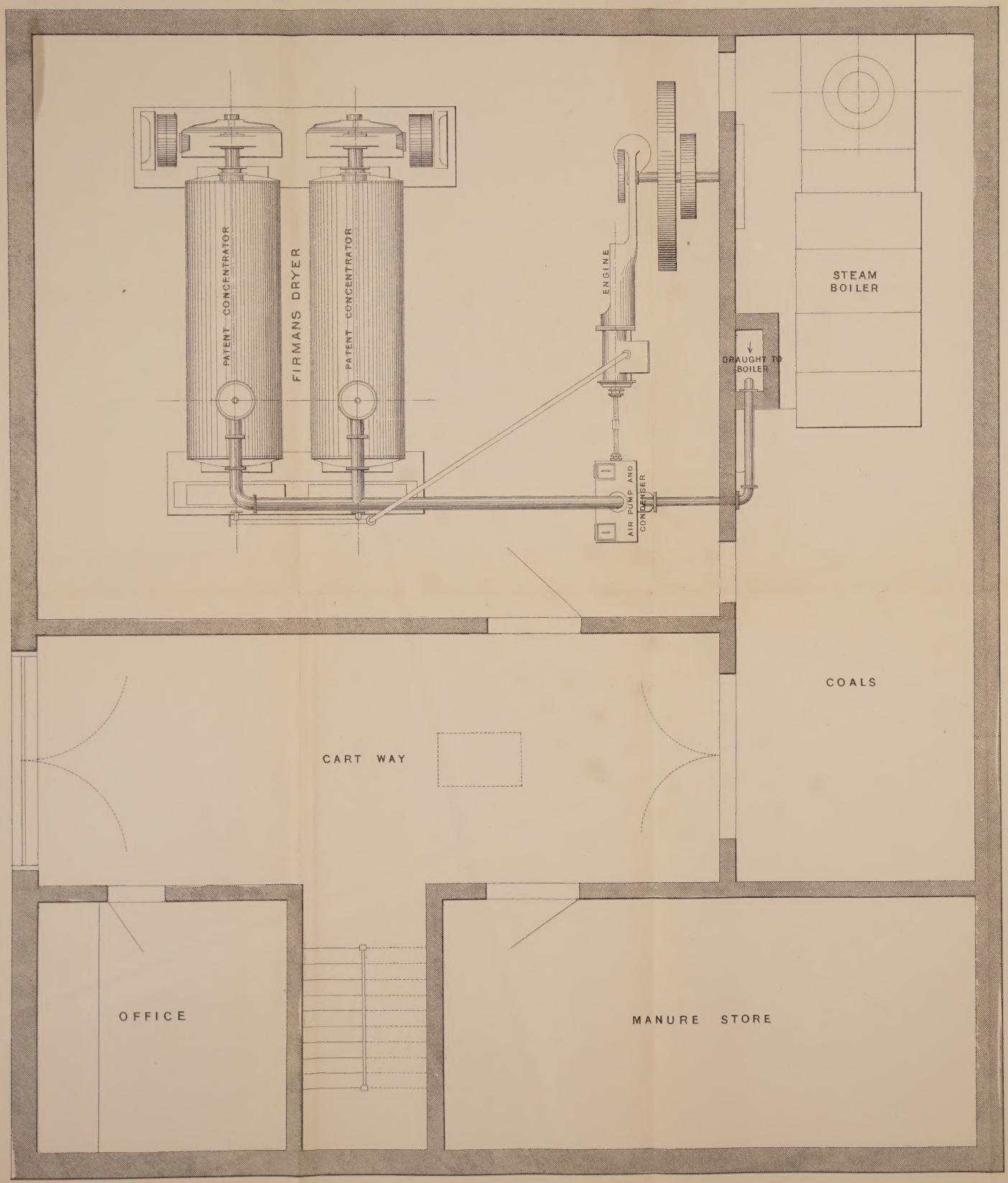
CROSS SECTION

A. *Feed inlet.*
B. *Exit for steam.*
C. *Steam space (Jacket)*
D. *Steam pipes.*
E *Steam heated hollow shaft.*
F. *Scrapers.*
G. *Fat cocks.*
H. *Discharge hole.*

SCALE ½ INCH TO ONE FOOT.

CHARLES SKIPPER & EAST, LONDON.

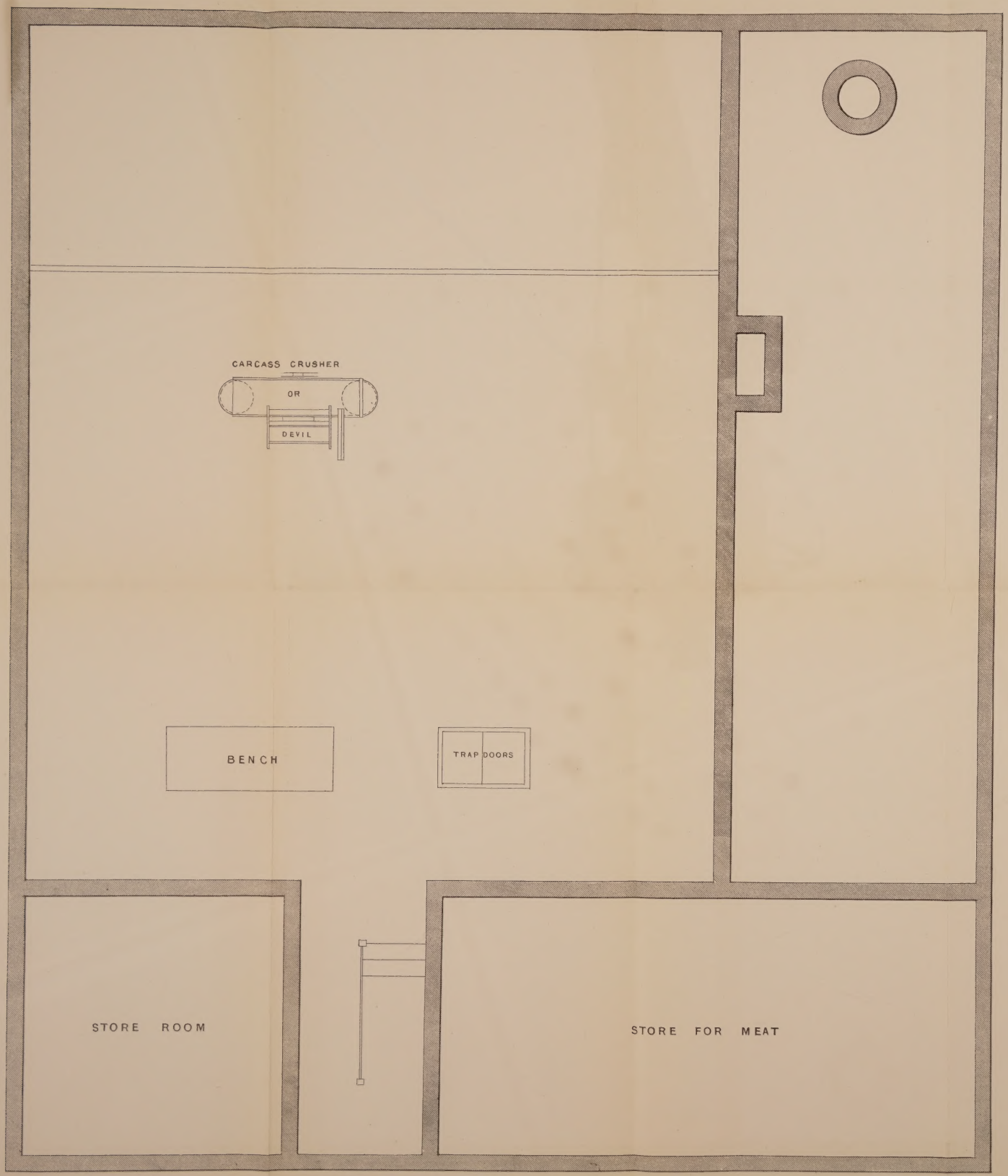
GENERAL ARRANGEMENT OF APPARATUS FOR TREATING CONDEMNED MEAT FOR THE CITY OF LONDON.



GROUND FLOOR

SCALE ¼ INCH TO ONE FOOT

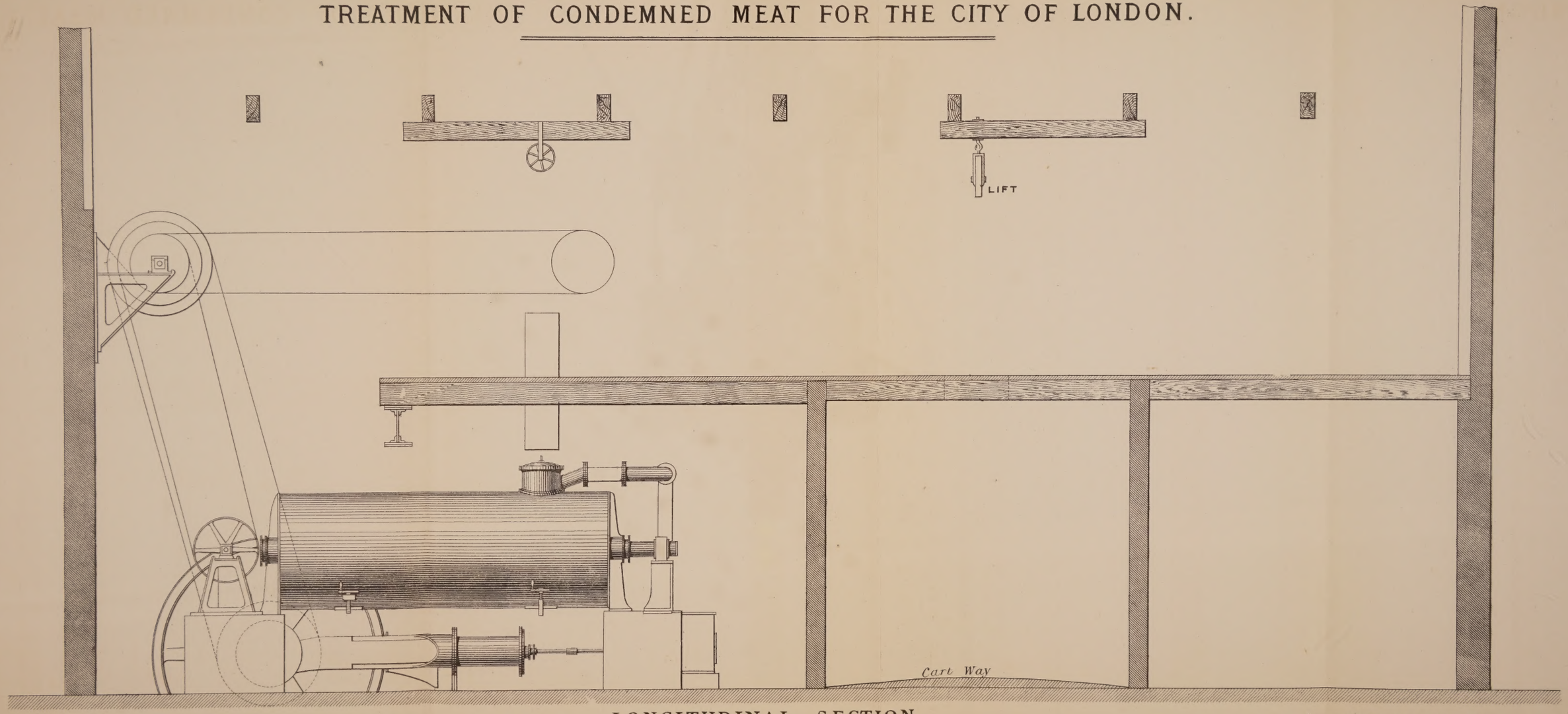
GENERAL ARRANGEMENT OF APPARATUS FOR TREATMENT OF CONDEMNED MEAT FOR THE CITY OF LONDON.



1ST FLOOR.

SCALE 1/4 INCH TO ONE FOOT

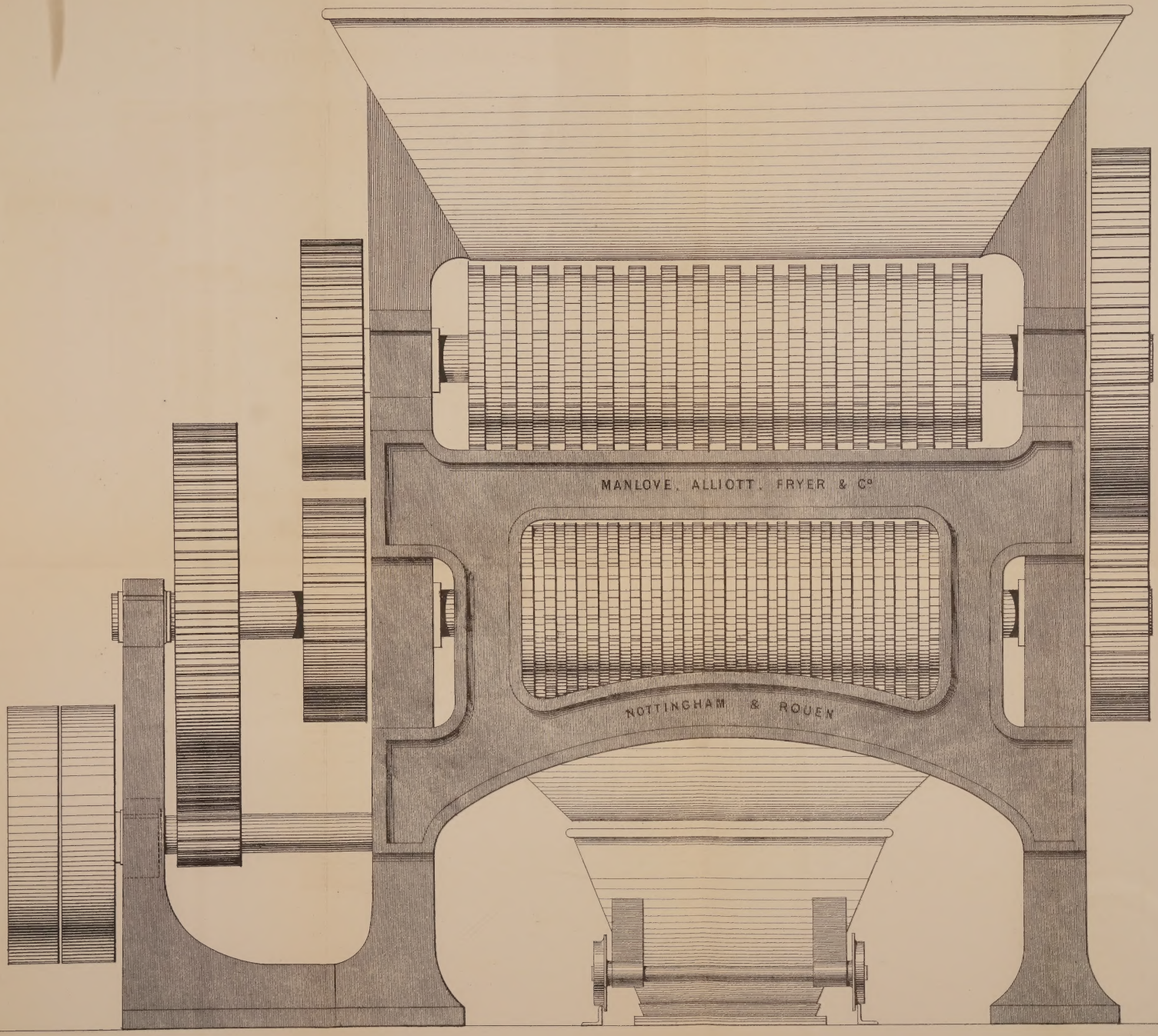
GENERAL ARRANGEMENT FOR THE TREATMENT OF CONDEMNED MEAT FOR THE CITY OF LONDON.



LONGITUDINAL SECTION.

SCALE ¼ INCH TO ONE FOOT.

CHARLES SKIPPER & EAST, LONDON.



SAUNDERS CARCASS CRUSHER OR DEVIL.

SCALE ⅛ FULL SIZE.

CHARLES SKIPPER & EAST, LONDON.